THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 68 NOVEMBER, 1952 No. 5

SOME OBSERVATIONS ON BONE GROWTH, WITH PARTICULAR RESPECT TO ZONES AND TRANS VERSE LINES OF INCREASED DENSITY IN THE METAPHYSIS

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AS IS well known, bone grows in length as a result of proliferation of cartilage cells at either end of the shaft or at the costochondral junctions. Inorganic materials are deposited in the organic matrix between the most mature cartilage cells, and on this scaffolding bone matrix appears and is strengthened by the deposition of calcium and phosphorus in it. Osseous tissues, particularly those which are growing most rapidly, are being continually destroyed and remodeled. In any discussion of bone, therefore, one must consider factors affecting the growth of cartilage, of which there are many, as well as alterations in the osteogenic-osteolytic balance. As a result of disturbances in chondroblastic, osteoblastic and osteolytic activities, one may encounter a number of changes in the bones of infants, children and adults and of experimental animals under a variety of circumstances. Such alterations manifest themselves histologically and roentgenographically in those areas where growth activity is maximal, that is, at the costochondral and epiphyseal-shaft junctions. In the present communication we should like to present and discuss certain examples of such phenomena, all of which have been derived either from autopsies on children dying from a variety of causes or from skeletal tissues of experimental animals treated in a number of ways.

At the outset it should be made clear that we know little or nothing of the mechanisms which govern the growth of cartilage, on the one hand, and of bone, on the other. It is quite clear, however, that chondroblastic and osteoblastic activities may be completely dissociated. So, too, the normal osteogenic-osteolytic balance may be upset as well. Such derangements will lead to profound changes in the skeletal tissues. The following examples should make the above generalizations evident and should help in explaining certain changes which may be prominent in the roentgenogram.

When one examines the end of a rib or a limb bone in a rapidly growing child who

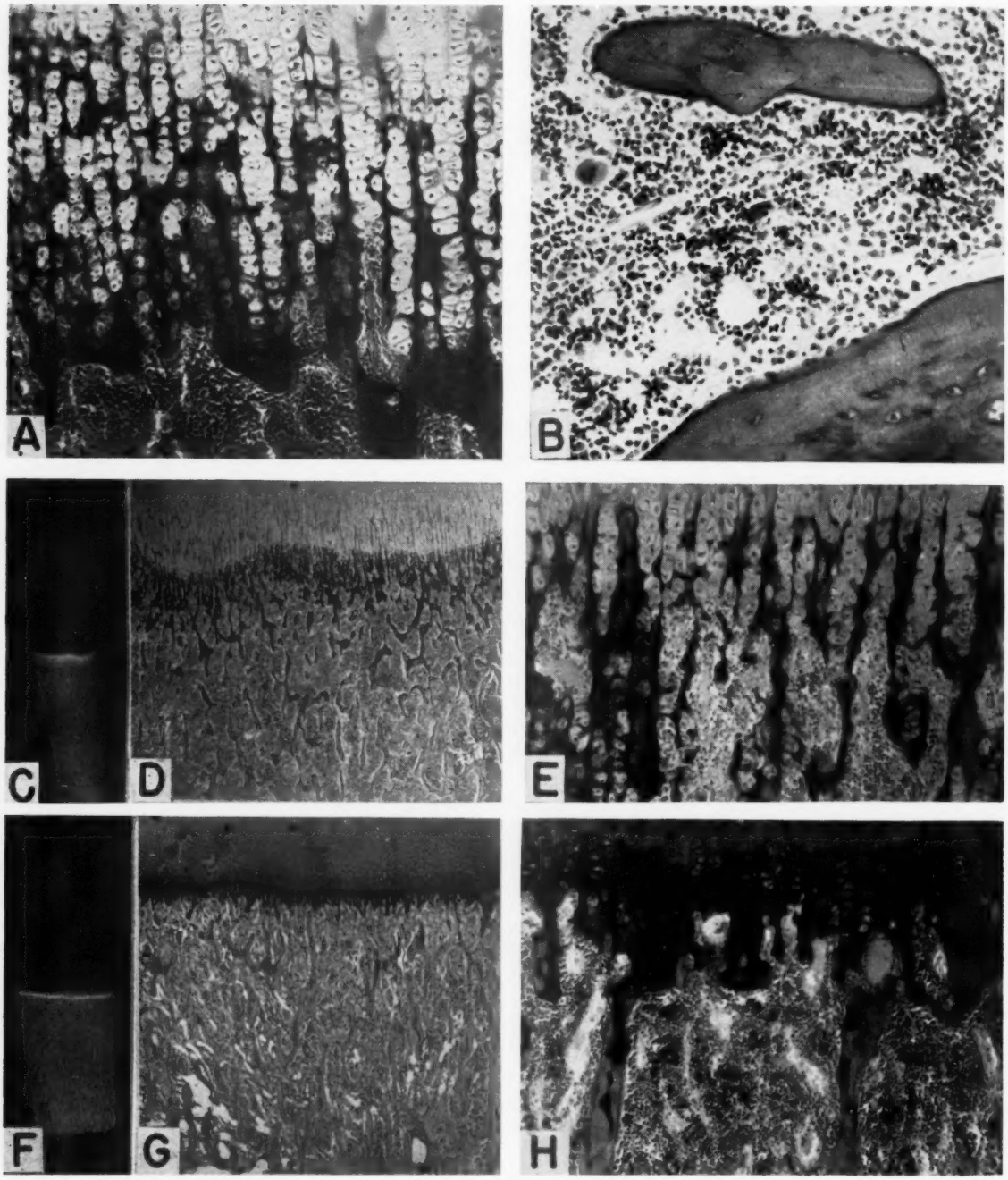


FIG. 1. (*A*) Typical heavy lattice of calcified matrix material. This is nonspecific. The subject was a twenty-eight day old premature infant dying of pneumonia and enteritis.

(*B*) Trabecula from above showing virtual absence of any osteoblastic activity.

(*C*) (*D*) (*E*) Roentgenogram of rib, low and high power photomicrographs of typical nonspecific lattice. This ten month old female died following a chronic illness of four weeks' duration, lobular pneumonia and pericarditis. This lattice is somewhat spotty in nature. The child had never received vitamin D, and slight rickets is present. Rickets would likely have been more marked had growth been more accelerated.

(*F*) (*G*) (*H*) Roentgenogram, low and high power views of typical nonspecific lattice in an older child (20 months) dying of a chronic illness, *i.e.*, teratoma of sacrum.

has died of a severe illness of a few days or more in duration, it is common to find at the end of the bone a distinctive formation (Fig. 1). This formation is composed essentially of a thick framework of calcified matrix substance in the upper interstices of which are found intact cartilage cells. It may be as long as the entire proliferative zone of the cartilage. As seen under the microscope this structure appears as a dense lattice which consists essentially of calcified matrix framework of the cartilage with retained cartilage cells. The calcification of the framework is heavy and can often be seen to extend into the horizontal cross bridges of matrix substance. Such a zone shows up as a bright zone in the roentgenogram, particularly if the bone, such as a rib, is studied outside the body. The microscope shows few osteoblasts and a paucity of new bone formation. It also discloses that the blood vessels are greatly reduced in number and that those which are present together with osteoblasts have only succeeded in penetrating the lower part of the lattice. But even in the most extreme lattice formation there is always some evidence of activity of the osteoblasts in the form of new bone formation in the lacunae of the cartilage cells, though this may only be sporadic. Also in the oldest part of the lattice, that on the shaft side, there is usually some evidence of destructive activity. Evidently the work of the osteoblasts and their accompanying vessels has been suppressed but not completely; osteoblastic activity is slight and sporadic, however, when compared to that seen normally. It is much easier to obtain a correct estimate of osteoblastic activity from an examination of the shaft than from the lattice because the cellular arrangement is less complex on the surfaces of the trabeculae. Turning then to the shaft we find strong corroborative evidence of the failure in cellular activity. The osteoblasts lining the shaft are few in number and have become flattened so as to be seen with some difficulty, and the physiological osteoid which tells us normally that fresh bone formation has occurred is wanting. Osteoclastic activity is also suppressed. Thus, in the shaft the whole process of cellular activity is at a minimum in both directions.

The lattice formation which we are describing can only be interpreted as the result of continued, though usually retarded, growth of the cartilage and failure of the shaft forces, namely the osteoblastic groups of cells and the blood vessels, to invade, remodel, and convert the framework supplied by the cartilage into shaft. It will be recalled that in rickets cartilage keeps growing and, as the result of the general disorganization of the growth processes at the cartilage-shaft junction, conversion into bone becomes impossible, so that the cartilage mass accumulates in front of the shaft. The condition in the bones of nonrachitic children which we have just described is analogous save that in these it is the calcified cartilage which accumulates. It should be added, however, that though we have correctly attributed the persistence of the lattice entirely to the failure of the osteoblasts and capillaries to perform their usual action, we cannot be certain that the cartilage cells themselves may not have been changed in some way so that penetration is rendered more difficult.

Some comments are now required. The two factors which are the cause of lattice formation, namely the continued growth of the cartilage and osteoblastic and vascular failure, are variables. It follows, therefore, that as the result of this break in coordination, the lattice itself must vary. As already pointed out, the great depth of the lattice is essentially due to the fact that the cartilage framework of matrix substance has not been removed and rebuilt but has accumulated. This matrix frame, certainly in most instances of lattice formation, is particularly heavy as if matrix production may even have been increased. Often the cartilage cells themselves appear shrunken and compressed by the thick matrix partitions and thick cell capsules so that the matrix

walls appear abnormally near together. Moreover, calcification itself may be unusually heavy, far more dense and extensive than is ever the case in the provisional zone of calcification in normally growing cartilage. When proliferative cartilage remains in contact with the shaft for some time, as when growth wanes, the calcification becomes progressively more dense and widespread. Finally, a stage is reached when only the cartilage cells themselves remain free of deposition of inorganic materials. Such intensity of calcification, as well as excessive matrix production in these cases of lattice formation, indicates that the growth of cartilage has been abnormal, being slowed though not being actually stopped.

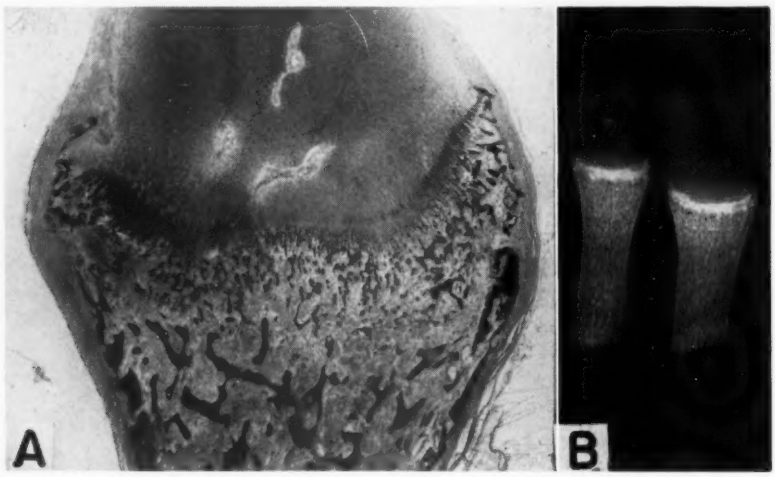


FIG. 2. (*A*) Costochondral junction from a six month old infant dying of dysentery following an illness of eight days. The baby had never received orange juice. Note concavity of shaft and widening of line of ossification. There are numerous fractures of nondestroyed calcified matrix material which account for the bright shadow seen in the roentgenogram (*B*). (From the Pathology of Nutritional Disease by Richard H. Follis, Jr., M.D. Charles C Thomas, Publisher, Springfield, Ill.)

The length of the lattice is obviously influenced by the rate of growth of the cartilage. The lattice formation in the rapidly growing middle ribs, for example, may be five times as long as at the more slowly growing upper end of the radius. Moreover, the time factor obviously enters in, so that if lattice production has been in operation for only a short time, the resulting formation will be small.

Turning now to the shaft factors, the lattice will be invaded, converted into bone and destroyed in proportion as the activities of the osteoblasts and blood vessels have been retained or awakened. In some cases evidently osteoblastic and vascular activities have been dormant and then have started again shortly before death. But when the shaft forces do attack the lattice in such cases it is always in an irregular manner similar to the irregular invasion of the accumulated cartilage mass in rickets. The lattice becomes extensively channeled, disrupted and broken up into chunks and may be so reduced that it consists only of fragments. Nonspecific lattice formation is the result of a growth disturbance of a number of days or weeks. Any severe febrile illness may result in lattice formation. Dysentery and the severe pneumonias following whooping cough, formerly diseases of extreme severity in infants and lasting in fatal cases for three to six weeks, have almost regularly produced extreme degrees of lattice formation.

These nonspecific lattice formations described above are to be compared with those which may be produced by specific means such as vitamin C deficiency and syphilis. In addition, lead, bismuth, and

elementary phosphorus poisoning, presently to be described may also lead to lattice formations which cast shadows at the ends of bones. The nonspecific lattices are usually not so well developed, however, and so far as we are aware, have not been pointed out as a cause of increased density at the extreme ends of the long bones of the extremities on roentgenographic examination.

The skeletal lesions encountered in human or experimental scurvy are the *par excellence* examples of the dissociation of chondrogenic and osteogenic activities. In organisms deprived of vitamin C, growth of the cartilage is unimpaired, at least until mechanical factors and general inanition manifest themselves. However, the osteoblast loses its potency to promote the deposition of osteoid on the framework of calcified cartilaginous matrix. Further, even more important for our discussion, the osteoblast is apparently unable to cause the destruction of this calcified matrix material. There results a seemingly brittle lattice which is prone to fracture close to the cartilage and which gives rise to the "bright" line so characteristic in the roentgenogram[12] (Fig. 2).

In certain cases of congenital syphilis a similar situation seems to exist (Fig. 3). Cartilage growth and the deposition of inorganic materials in the matrix to furnish a framework for the deposition of osteoid go on in fairly normal fashion. However, the osteoblast is in some way damaged so that it is impotent to promote the formation of bone matrix and to destroy the calcified cartilage matrix.[13] The latter remains and shows up in the roentgenogram as a bright radiopaque zone at the ends of the bone. Remnants of such shadows may remain deep in the shaft for some time after the disease has healed and normal bone growth has been resumed.

Soon after roentgenography made possible the study of the finer structure of bones, so-called transverse lines were observed in the roentgenogram and it was noted that their occurrence could be dated

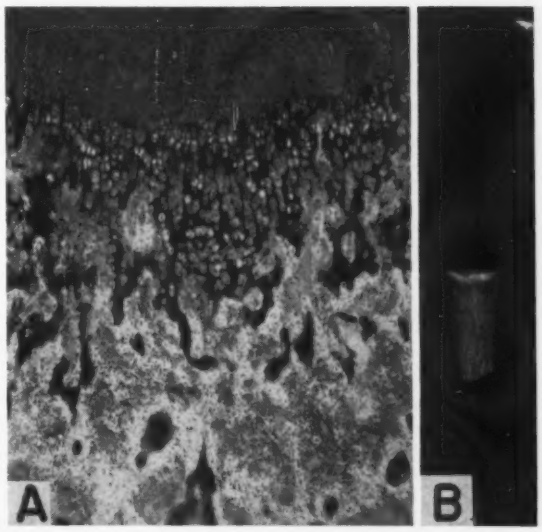


Fig. 3. (*A*) (*B*) High power photomicrograph and roentgenogram of same rib to show dense irregular lattice encountered in congenital syphilis. The disease was not recognized in this thirty day old infant and there was no treatment. The lesions are not extreme.

with acute illness.[4] Indeed the dating proved to be so exact that transverse lines have been used to measure the rates of growth of the various long bones. What are these transverse lines anatomically? Actually they are not transverse lines at all but transverse strata which appear as lines in the roentgenogram because caught on edge when the bone is laid parallel to the film surface. The strata are composed of horizontally directed trabeculae, many of which join to form an interlacing network. They are produced by dissociations between the growth of the cartilage cell and the osteoblast, this time the cartilage cell being the recessive and the osteoblast the dominant factor.

The general principle determining the development of these strata is that when the growth of the cartilage stops, the osteoblasts are unable to expend their stored energy in the vertical direction and are forced to expend it laterally along the under surface of the cartilaginous plate (Fig. 4 and 5). The steps appear to be as follows: When the cartilaginous growth stops, the capillaries with their attendant osteoblasts

penetrate all the cartilage cell capsules of the provisional zone which are dead and hence can be penetrated, and in so doing lay bare the separating walls of matrix substance. They then reach the living cartilage cells but these apparently cannot be broken into. Since the capillaries and osteoblasts find further progress in the longitudinal direction blocked, they are compelled to spread out laterally in all directions along the under surface of the cartilaginous plate. The osteoblasts, concentrated as a result of the blockage of their forward progress, settle on the exposed walls of the matrix framework and layer them over with bone. Bone formation occurs in the horizontal plane because, owing to the barrier furnished by the under surface of the cartilaginous plate, the horizontal plane is the only one affording space for growth expansion. Additional factors may enter in. We have often observed in rickets, scurvy and

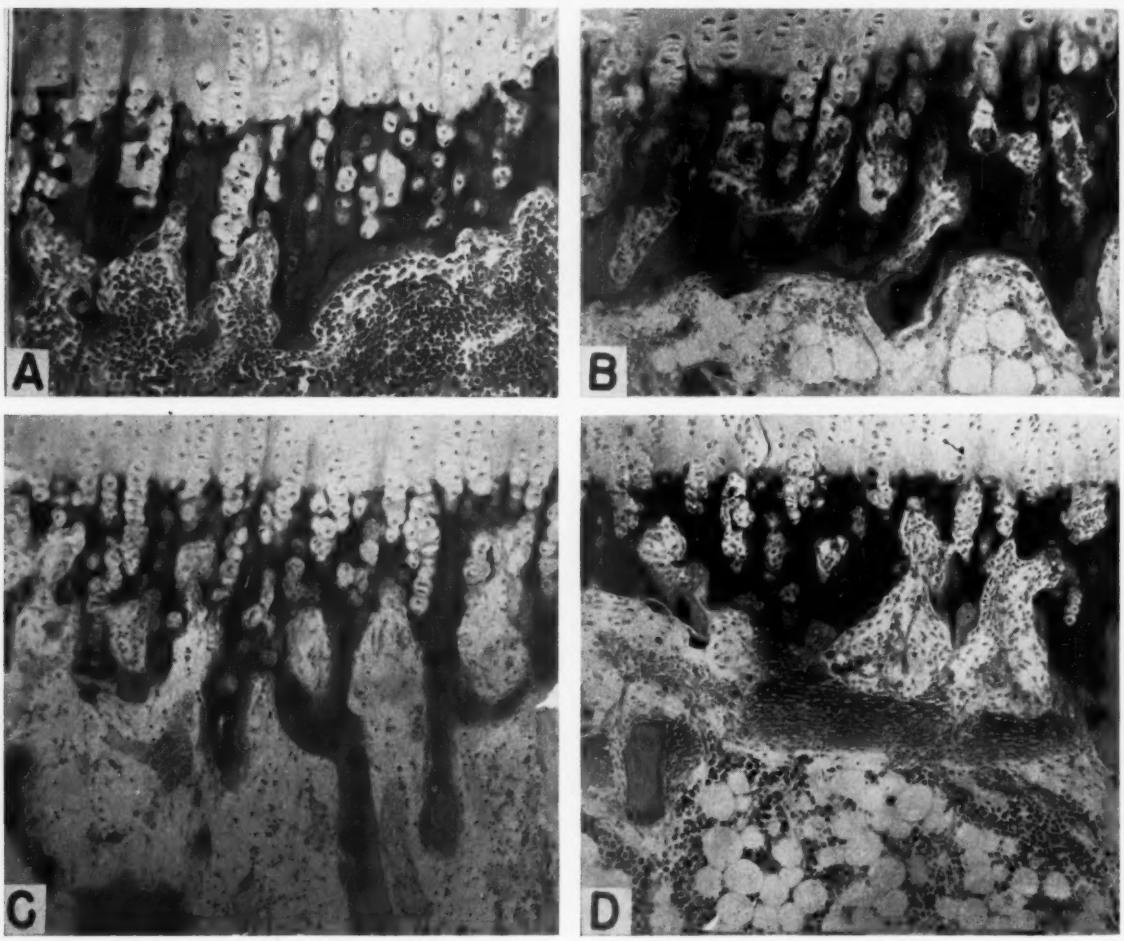


FIG. 4. (*A*) Section to show bone being deposited on the under surface of cartilage matrix which is stubby and the cells of which appear inactive.

(*B*) In this the bone on the matrix is lower and it would appear that the cartilage is more active and has begun to grow after its deposition in contrast to (*A*).

(*C*) This shows cross bridging of trabeculae. Note moderate lattice with imprisoned cartilage cells and decrease in hypertrophic zone. Bone formation is going on but cartilage has virtually ceased growing. This was a seven months old infant dying of intussusception after eight days.

(*D*) This shows another type of transverse line formation due to the production of metaplastic or membranous bone. A ten month old infant dying of pertussis and pneumonia. Total duration of illness was one month.

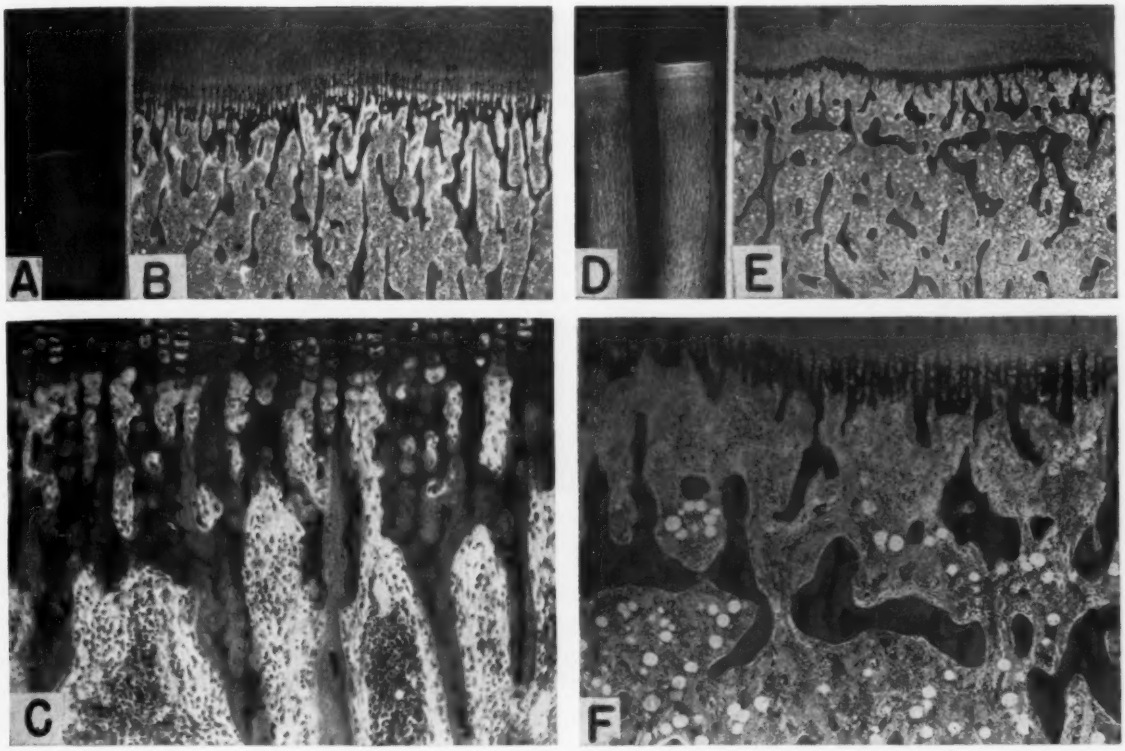


Fig. 5. (*A*) (*B*) (*C*) Roentgenogram, low and high power views of transverse line in the process of being formed and set free. The roentgenogram shows nothing because the line is too close to the cartilage. Line is best shown in (*B*). The higher power shows bridging on the left. This was a twenty-one month old child who had a two weeks' history of measles and intestinal obstruction.

(*D*) (*E*) (*F*) Roentgenogram, low and high power views of well developed transverse line. This fifteen month old child was in the hospital for $7\frac{1}{2}$ weeks. The transverse trabeculae are particularly striking in (*F*).

congenital syphilis that proliferative cartilage which has been exposed to the shaft environment for some time tends to develop a thick matrix. The stagnation of the capillaries and osteoblasts along the under surface of the cartilaginous plate may increase the formation of matrix substance for the osteoblasts to build upon. With such stagnation, calcification of the matrix substance undoubtedly extends and becomes more dense. Calcification, however, is not a factor in transverse strata formation because this anomaly occurs with great frequency in rickets in which disease calcification is defective (Fig. 6 and 7). Osteoblasts appear to seek out preferentially for purposes of bone formation small nooks in the framework of calcified matrix substance such as the empty capsules of the cartilage cells where they find themselves effectively walled in. This apparent peculiarity of the osteoblasts may also be a factor in transverse strata formation. At any rate, we have repeatedly observed the osteoblasts between horizontal trabeculae evidently in process of completing a junction of the two. In all probability growth of the cartilage may not be completely halted, i.e., a slight degree of growth with consequent slow maturation of the under surface of the cartilaginous plate continues to occur and this slight degree of growth may favor the development of transverse trabecular formations of increased width by furnishing an increased amount of horizontally disposed matrix framework for the osteoblasts to settle upon.

Transverse strata always form at the cartilage-shaft junctions and have the contour of the latter. Moreover, they always

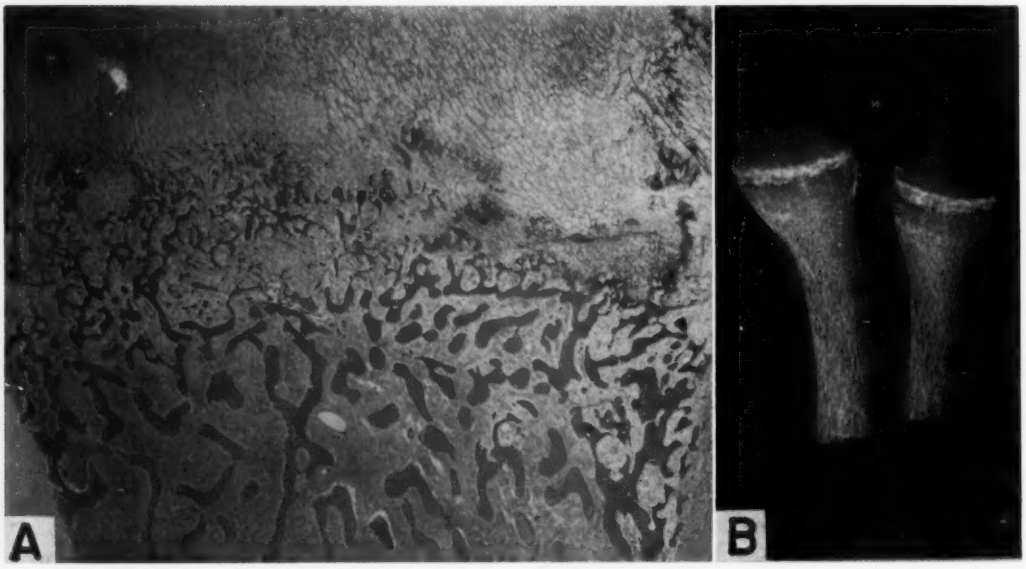
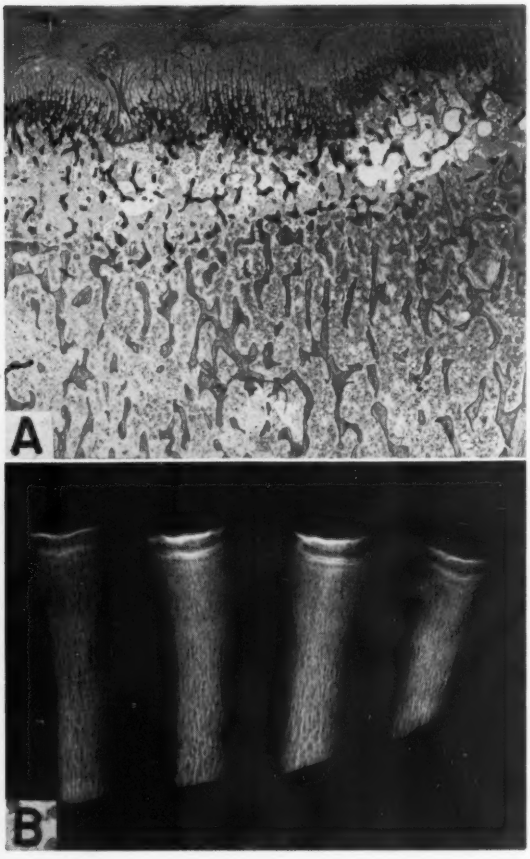


FIG. 6. (*A*) (*B*). Low power and roentgenogram to show transverse formations in chronic severe rickets. This marks the beginning of the disease. The cause is different from nonspecific formations. The rachitic cartilage next to the shaft having lost the support of calcified matrix collapses and furnishes a barrier to the advance of the capillaries and osteoblasts. These must spread out and produce bone matrix (osteoid) on the under surface of the cartilage. The principle of formation is the same but the barrier is not due to growth cessation of the cartilage.



occupy the original positions in the bone in which they were formed. When one encounters a transverse stratum well down in the shaft of a long bone, the explanation is that the cartilage has grown away from it, *i.e.*, left it in its wake (Fig. 8). In slowly growing bones, transverse strata will be found close to the cartilage, whereas in rapidly growing bones they may become widely separated. Although transverse strata always start at the cartilage-shaft junction, they frequently continue to progress for some time. Often we have observed that a transverse stratum well down in the shaft is continuing to extend as the result of osteoblastic activity. Sometimes the osteoblasts are bringing the horizontal arms of the trabeculae together by apposi-

FIG. 7. (*A*) (*B*) Low power view and roentgenogram to show rickets in process of repair. The disease is still progressing in a smoldering sort of way in the cartilage, although a great deal of healing has taken place. This was a sixteen month old child dying of extensive tuberculous meningitis.

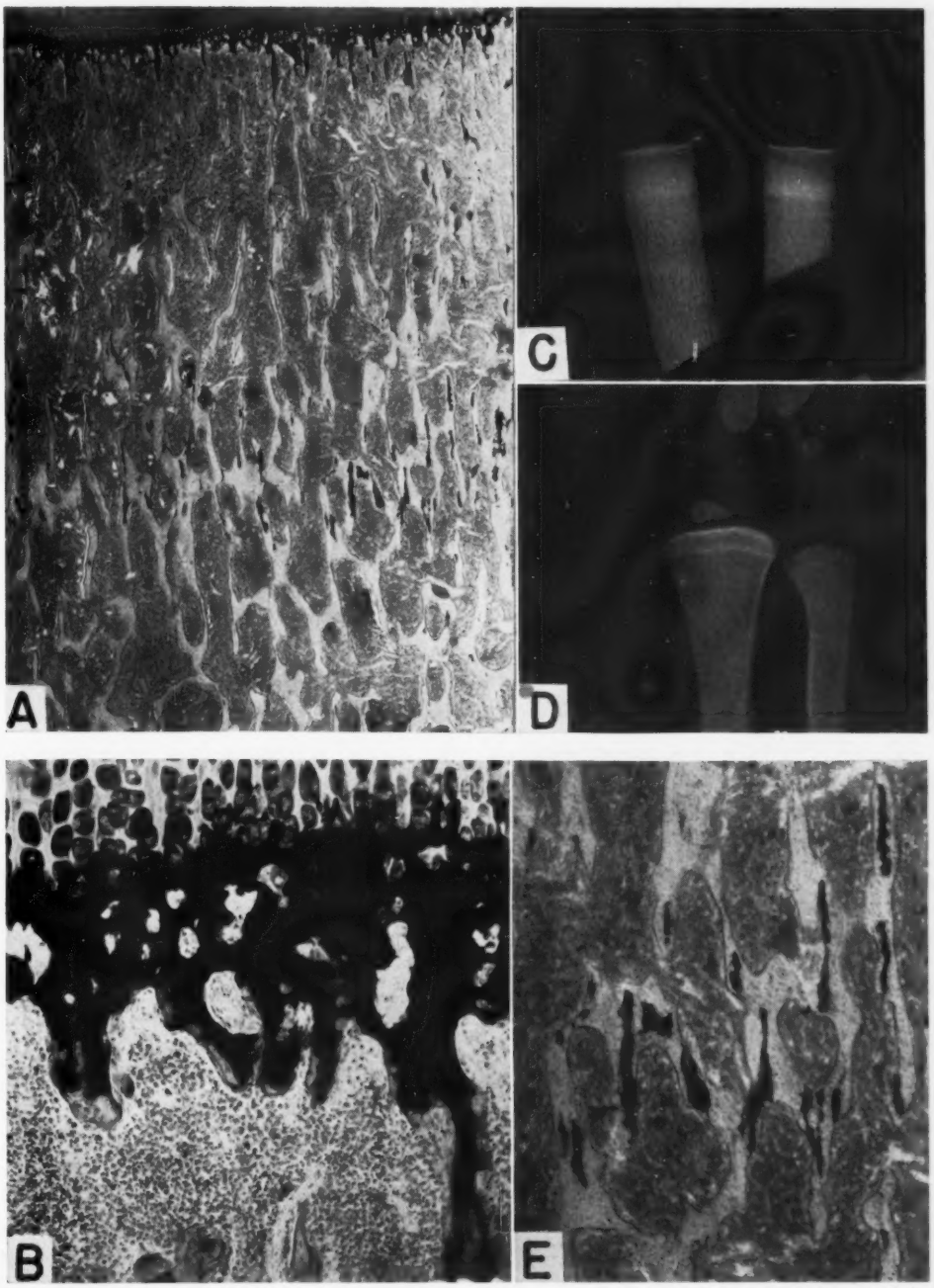


Fig. 8. A two year old child dying of a chronic illness, *i.e.*, empyema. (*A*) Low power view of rib. Note heavy lattice shown in higher power in (*B*). There is virtual complete cessation of growth of the cartilage. Note bone on under surface of lattice. Note also deep in shaft a transverse line exemplified by an increased number of trabeculae with remnants of the original calcified cartilaginous matrix. This is shown in higher power in (*E*) and was, of course, formed some time before. (*C*) Roentgenogram of rib to show broad band approximately 5 mm. beneath the cartilage; this, of course, corresponds to the zone seen in (*A*) and (*E*). (*D*) Roentgenogram of wrist of same subject. This is to exemplify the transverse line which is not nearly so far from the cartilage as in the rib. The explanation is obvious, *i.e.*, difference in growth of the two structures.

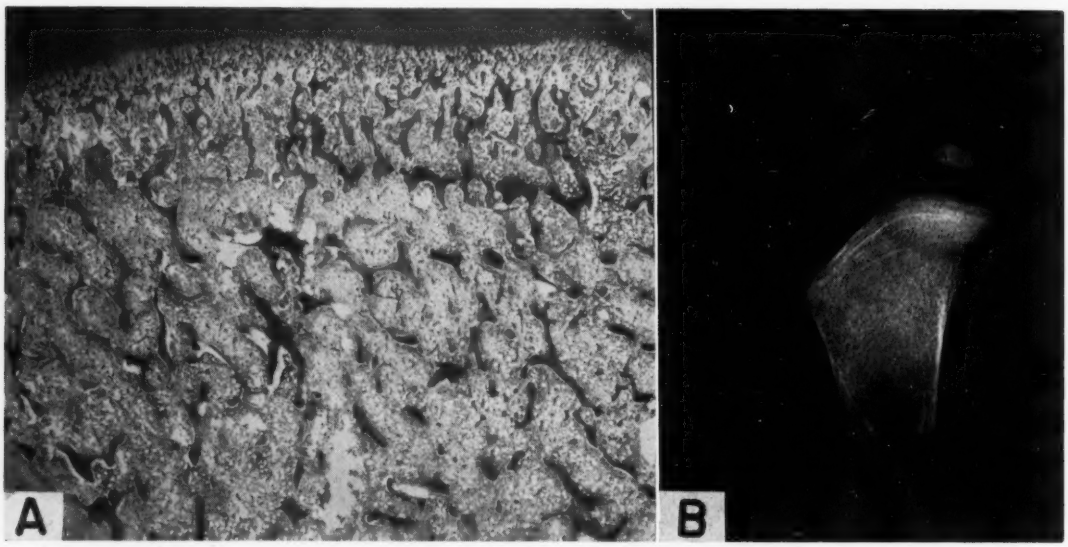


FIG. 9. (*A*) (*B*) Low power and roentgenogram of head of femur. A ten month old child who had been in the hospital four months, suffering from a subdural hematoma. There are several transverse lines.

tional bone formation, sometimes by membranous, sometimes by both in combination.

Oftentimes in the substance of the shaft it is possible to see evidence that cessations of cartilaginous growth have been occurring one after the other for a long time as a result of the many telltale transverse strata one above another (Fig. 9). These strata may stretch entirely across the shaft, in which case they appear as transverse lines in the roentgenogram or they may be only partially developed involving only small groups of trabeculae here and there. It is common to find in the substance of the shaft another evidence of growth disturbance in the form of giant trabeculae which may, however, have a different origin than the transverse strata just discussed. Giant trabeculae originate from chunks of lattice which have been cut off intact as the result of piecemeal invasion, to be later filled in and covered over with bone as the result of continued osteoblastic activity. These giant trabeculae can sometimes be picked out in roentgenograms.

Transverse strata of horizontally disposed trabeculae are exceedingly common in the growing bones of children. The onsets of severe rickets and scurvy are sometimes marked in the bone by the formation of transverse strata and it is common to find a transverse stratum on the under surface of a lattice, meaning that the first shock of disease produced a temporary check in cartilaginous growth which the osteoblasts promptly inscribed. It is interesting that transverse strata cannot be produced by severe inanition under which cartilaginous activity and junction of the osteoblasts presumably suffer equally. However, zones of increased density in the roentgenogram such as those which are encountered in our human material may be produced experimentally by dietary means providing one is able to juggle the various factors in appropriate ways[7] (Fig. 10). Interference with growth by a variety of ways—caloric restrictions, protein deprivation, or deficiencies of one or more of the forty-odd essential nutrients—may, upon the resumption of growth following the return of the experimental animal to an adequate diet, bring out zones of increased density. Such areas are due to an overproduction of bone, that is, excessive osteoblastic activity, over and above normal osteolytic sequences.

The occurrence of transverse strata in bones may be the result of illnesses of a most temporary and relatively mild nature and indicate that the mechanisms which

preside over the growth of cartilage must be adjusted with great delicacy. They are evidence that the cartilaginous growth must be subject to sudden halts and equally sudden resumptions and also that the genetic urge upon the cartilage for growth fulfillment must be powerful since it is so persistent under conditions under which the osteoblasts at least become incapacitated. Lattice formations differ also from the transverse strata of trabecular formation in that when osteoblastic activity is resumed they are remodeled and removed. The lattice formation of scurvy and congenital syphilis does not produce transverse lines. The transverse lines in the shafts of bones never have their origin in the healing lines in the cartilage in rickets. Neither lattice nor transverse stratum formations can be regarded as scars. The lattice formations are to be thought of as examples of incomplete growth and transverse strata appear to be misdirected growth, neither good nor bad as far as the interests of the bone are concerned.

Fig. 10. Upper ends of tibia from 2 rats, 50 grams at beginning of experiment. They were placed on a diet completely deficient in protein and promptly stopped growing. After three weeks one (*A*) was sacrificed. Protein was added to the diet of (*B*), which started growing at an accelerated rate with extensive production of bone which casts a dense shadow.

We should now like to call attention to another group associated with structural alterations in the bones of children or experimental animals. These like the nonspecific lattice formations and those of scurvy and congenital syphilis produce in the roentgenogram not lines but zones of increased density.

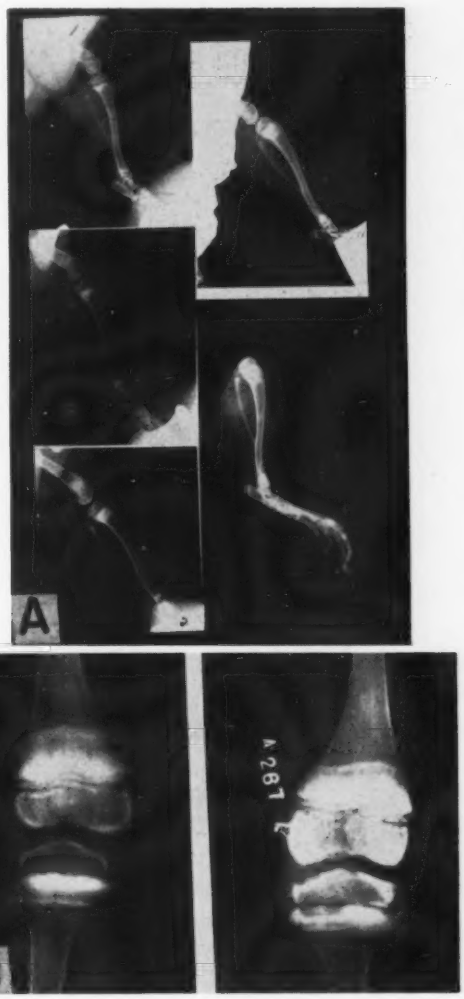


Fig. 11. (*A*) Successively widening zones of increased density in rat which had received elementary phosphorus. (*B*) Knee of child who had received elementary phosphorus to show the tremendous increase in density which may occur.

The first of these is found following the administration of elementary phosphorus (Fig. 11 and 12). The effects of this inorganic element were first noted eighty years ago by von Wegner who showed that a dense band of bony tissue develops beneath the cartilage when elementary phosphorus is fed to calves.[19,20] Intermittent feeding resulted in alternating strata. Following these observations there accumulated a large literature on the use of phosphorus in

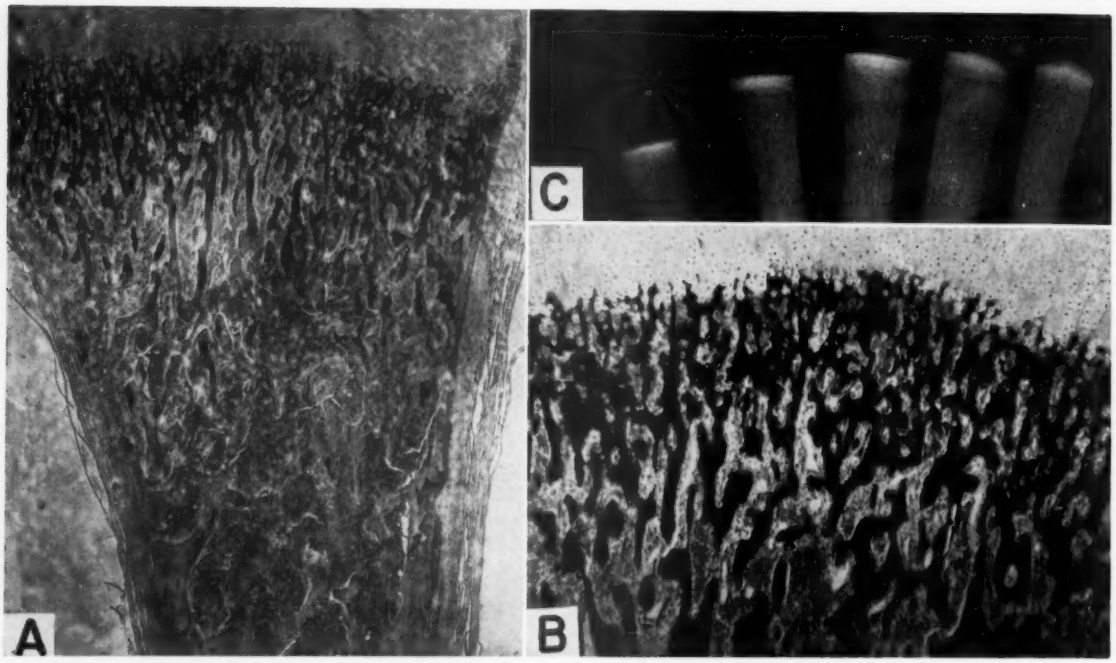


FIG. 12. (*A*) (*B*) (*C*) Low and high power views and roentgenogram of same of a costochondral junction of an eighteen month old baby dying of lead encephalitis. There is a dense zone of calcified (and plumbified?) matrix encased in bone beneath the cartilage. As is so frequent, some rickets is present as evidenced by a lack of dark staining material in certain areas of mature cartilage cells.

the treatment of rickets; we shall not review this here. Studies in rats have confirmed von Wegner's observations.[9,14] The zone of increased density is apparently due to a stimulation of osteoblastic activity; numerous mitotic figures may be observed in osteoblasts.[14] In addition, there is undoubtedly interference with destructive activity. A change somewhat similar to that found following elementary phosphorus administration has recently been described in mice receiving radium or plutonium.[1] Microscopically, however, the latter alterations would appear different and are doubtless the direct result of irradiation.

Another element, lead, is associated with conspicuous changes in the skeletal tissues of children, as was pointed out a number of years ago[10,11] (Fig. 12). Lead poisoning in young children, at least in Baltimore, is something with which to reckon even today; in the autopsy files of the Johns Hopkins Hospital there is material from the skeletons of 57 children dying as a result of lead encephalitis. The pathogenesis of the osseous changes is not entirely clear. Histopathologically[10,11] there is, at the cartilage-shaft junction, a dense zone of blue staining calcified (and perhaps plumbified) cartilaginous matrix encased in bone. This material would seem to be refractory to the usual cellular destructive mechanisms so that it remains and therefore casts a characteristic shadow which may be encountered on roentgenographic examination. Histopathologically, lead poisoning in the bones is characterized by the presence of innumerable multinucleated giant cells or osteoclasts about the masses of deeply staining matrix encased in bone. The size and numbers of these cells are unique and have not been observed in the bones in other conditions.

Another heavy metal which may produce histological changes or shadows in the roentgenogram is bismuth. Today one would doubtless not encounter the phenomena produced by this element in human autopsy material. In previous years when bismuth was administered to the mother

before delivery or after birth to the child in the treatment of syphilis, bismuth "lines" could be detected in the roentgenogram. Such areas when studied histologically reveal zones of dense trabeculae, corresponding to the interval during which the material was administered. Bismuth does not lead to histopathological changes similar to those found in lead poisoning either in the human or the experimental animal.[2,21] The cause for the increased density is undoubtedly excessive osteogenic and decreased osteolytic activities.

It may be of interest to point out certain related changes which may be produced in the experimental animal as a result of an apparent disruption of normal osteogenic-osteolytic sequences. Stimulated by the profound alterations which may be encountered in the bones of birds[16] or mice[8] as a result of estrogenic stimulation, large amounts of estrogen were administered to both growing and mature rats.[3] Contrary to the avian and mouse experiments where tremendous endosteal osteoblastic activity with transformation of the medullary cavity into solid bone is observed, in the growing rat a zone of increased density was found only in the metaphysis; this area corresponded to the period during which the hormone had been administered. No excessive endosteal activity could be found; nor were changes observed in adult animals in which growth had virtually ceased. These findings have been interpreted as being due to an interference with normal resorptive sequences, a conclusion which has been upheld by others.[18] It is of interest that in numerous other species which have been studied—guinea pigs, rabbits, hamsters, kittens and puppies—changes similar to those observed in the rat have not been found.[18]

An analogous change, again apparently due to an inhibition of osteolytic activity, has been observed in rats treated with appropriate quantities of cortisone acetate.[5] This hormone was administered in the hope of producing osseous changes which form such a prominent part of Cushing's syndrome in the human.[6] However, instead of the hoped for rarefaction, zones of increased density were found beneath the cartilage and these conformed to the time of administration of the hormone. When this is stopped, the bone whose growth has been retarded begins to grow again and the zone of increased density may be seen weeks later as a transverse formation deep in the shaft.

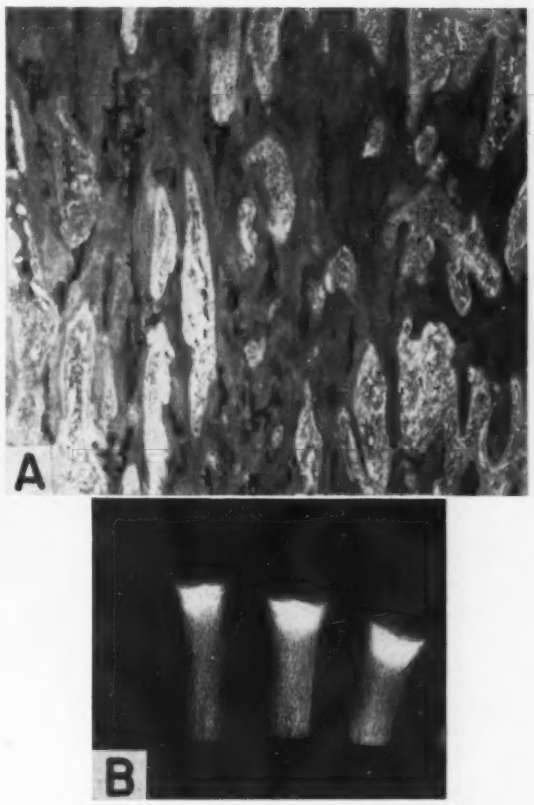


Fig. 13. (*A*) (*B*). This seven month old congenital syphilitic had been treated with bismuth for some time before death from lobular pneumonia. Note dense bone in shaft of rib (*A*) which shows up so well in roentgenogram (*B*).

A third hormone, the active principle in parathyroid extracts, may, in appropriate dosage, lead to an excessive deposition of bone at the growing ends in the rat.[15,17] Such formations which are interpreted as resulting from osteoblastic stimulation are much more readily produced by altering the normal calcium-phosphorus ratio of the diet. Further experiments are necessary to

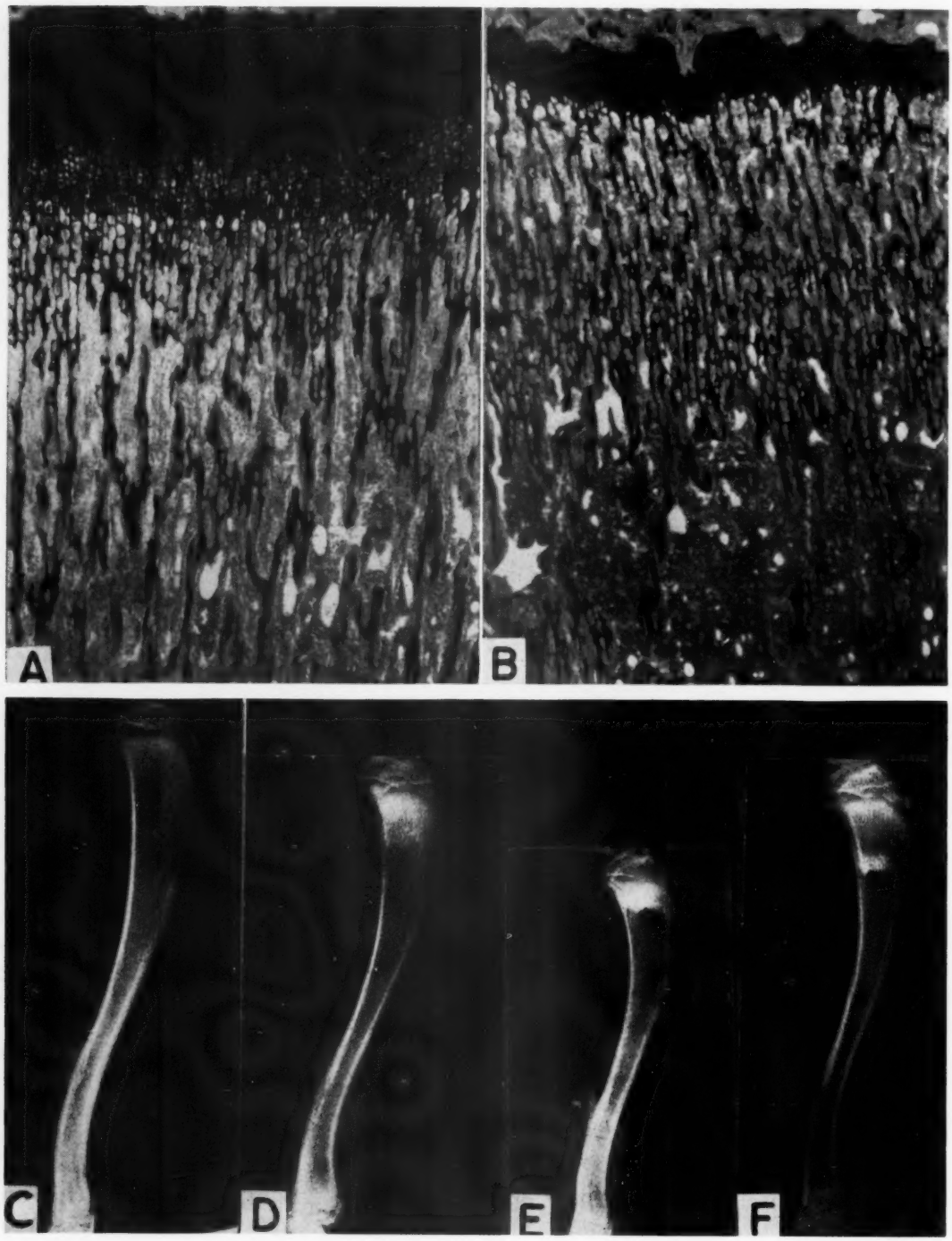


FIG. 14. (*A*) Tibia from a normally growing rat to show broad cartilage and trabecular pattern beneath. (*B*) Tibia from rat of same age treated with cortisone acetate for sixteen days in a dosage of 50 mg./kilo. Note narrowing of cartilage plate indicating growth arrest but persistence and increase in the trabecular pattern. (*C*) Roentgenogram of tibia of normal rat. (*D*) Zone of increased density in metaphysis of estrogen treated rat. (*E*) Zone of increased density in metaphysis of cortisone treated animal. (*F*) Zone of increased density down in shaft of a cortisone treated animal allowed to live for three weeks after cessation of therapy.

clarify the changes which have been observed, however.

DISCUSSION

From the examples which have been cited above it becomes quite apparent that differences in growth activity of cartilage cells and in bone matrix formation by osteoblasts and in destruction of calcified cartilage and/or bone matrix by osteoblasts and/or osteoclasts will lead to a variety of changes which manifest themselves under the microscope or in the roentgenogram. In the present communication, we have been concerned primarily with the zones of increased density which may be encountered at the ends of growing bones as well as with transverse formations in the shaft. It seems hardly necessary to point out that bone disease in general may be classified on the basis of disturbances in three normal phenomena; chondroblastic activity, osteogenic-osteolytic balance and deposition of inorganic materials in cartilage matrix and/or osteoid.

We believe it is desirable to stress one point upon which there would appear to be some confusion in the literature at this time. As the title of this communication indicates we have chosen to sharply demarcate *zones* of increased density at the ends of growing bones from *transverse lines* of increased density. We believe this is important because the pathogenesis of the two may be quite different. *Zones* of increased density result from an overproduction and usually associated failure of destruction of calcified cartilage matrix material, whether caused by nonspecific or specific mechanisms. This matrix may be covered with varying amounts of bone. *Transverse lines* of increased density, on the other hand, result in large part from bone formation in a horizontal plane, along the under surface of the cartilage. The mechanisms operating to produce *zones* and *lines* may operate together, as might be expected; more frequently, however, the pathogenesis of the two may be separate.

SUMMARY

A group of diverse disturbances in bone formation in children and experimental animals has been presented. All of these lead, as a result of one or another factor, to the histopathologic and roentgenographic appearance of zones or transverse lines of increased density in the metaphyseal regions. An analysis of the pathogenesis of such areas brings out in striking manner the independence of chondrogenic and osteogenic activities, on the one hand, and of osteogenic and osteolytic functions, on the other.

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FOREIGN BODIES DISCOVERED BY CHEST ROENTGEN SURVEY*

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IT IS common knowledge that many mentally ill patients swallow foreign bodies or introduce them into the various natural openings of the body. It is much less well known, although apparently not extremely uncommon, that the mentally ill also introduce foreign bodies subcutaneously. An interesting by-product of roentgen surveys of patients in the mental institutions in California[1] is the identification of foreign bodies in the miniature chest roentgenograms of 28 individuals. These instances occurred among a total of approximately 45,000 mentally ill patients in the course of three annual surveys, including those roentgenographed in the initial survey and those subsequently admitted. The foreign bodies discovered fell into three categories, depending on the location of the foreign bodies—subcutaneous, intrapulmonary, and mediastinal.

There were 18 individuals in whom subcutaneous foreign bodies were found, 9 males and 9 females. In all but one, the foreign body consisted of sewing needles or portions of needles, or the pointed portion of common pins. The needles in some cases were introduced in their entirety; it was obviously necessary to break the pins in two pieces since the heads of pins could not be forced through the skin. In 1 case there were two strands of fine wire several centimeters long in the anterior chest wall. In most of these cases the foreign bodies were introduced into the subcutaneous tissues of the anterior chest wall, more commonly the lower left portion, and, in a few cases, in the anterior abdominal wall. In one individual, the distribution was much more extensive (Case 1).

In preparing to introduce the pointed portion of pins subcutaneously, the patients bent the pin at its center until the pin was broken into two pieces. The pointed portion would then be forced completely through the skin. In only the few cases where infection resulted was this practice known to the physicians and attendants. The absence of infection in most of these patients is indeed amazing. In 2 cases the needles gave evidence of some degree of absorption, indicating they had been in the tissues a long time. In 1 case, they showed incrustation with calcium.

There were 8 patients with intrapulmonary foreign bodies, 1 of whom had also introduced a needle in the anterior abdominal wall. Six of the 8 patients had a single pin or needle in the right lower lobe, well out in the parenchyma, with no evidence of inflammatory reaction. One patient had a medium-sized, flat-headed screw in the right lower lobe bronchus with considerable attendant pulmonary suppuration and atelectasis of the right lower lobe. One patient had introduced some unidentified type of metallic foreign bodies in the right main bronchus with distal lung suppuration. This patient was known previously to have introduced various types of foreign bodies into the lungs and had had several removed by bronchoscopy.

There were 4 patients with foreign bodies, apparently pieces of needles and the pointed part of safety pins, located, not within either lung, but in the mediastinum, anterior to the spine. It is supposed that these objects had been swallowed and had perforated the esophagus, in order to reach the location in which they were found. Some of these patients are known to have swallowed various foreign bodies.

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FIG. 1. Case 1. Pointed portion of pins introduced into the tissues of the anterior chest wall by the patient. Discovered by roentgen survey.

REPORT OF CASES

CASE 1. H. J. E., female, aged fifty-five. Following a short period of teaching in a country school, the patient entered Stanford University at the age of twenty-one. The quality of her work, however, declined gradually, and in her second year she was formally removed from the student roster. Her mental condition became such that at the age of twenty-five she was committed to one of the California mental institutions where she has been a patient for the past thirty years. The admission diagnosis was dementia praecox, hebephrenic type.

FIG. 2. Case 1. Lateral view of same patient, showing that all the pins are located in the anterior chest wall and are not intrapulmonary.

At the present time the patient is rather badly deteriorated and has constant singular and fantastic hallucinations with no effort to support them with reason or logic. She gathers trash, cord, bread crusts, and orange peelings. She eats little at mealtime, is quiet and cooperative, but too deteriorated to assist with even light duties on the ward.

In the course of the first photofluorographic survey of the patients in Napa State Hospital, this patient's miniature chest film presented images of a very large number of metallic objects (Fig. 1). Most of the objects were straight, pointed at one end, and slightly bent at the other end. They were scattered over the middle and lower parts of the lung fields and through the axillae and upper parts of the arms. A lateral view (Fig. 2) showed these objects to be located entirely in the anterior chest wall

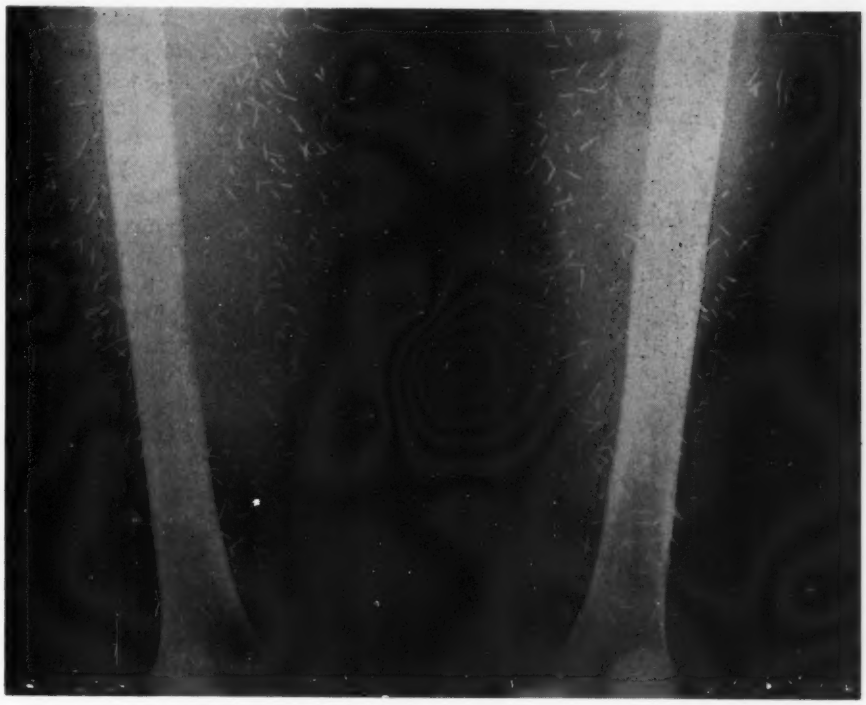

Fig. 3. Case 1. Soft tissues of both thighs riddled with pins; this condition extended through both legs. Over 1,400 portions of pins were counted in roentgenograms of this patient's body.

between the skin and the ribs. Roentgenograms of other parts of the body were secured and the same type of objects were found in great concentration beneath the skin from the crest of the ilium on each side throughout the tissues of the thighs and the upper half of the legs (Fig. 3 and 4). A few were even discovered in the scalp and one in the lobe of one ear. By actual count, there were a total of over 1,400 foreign bodies in the tissues of the chest, abdomen, thighs and legs of this patient.

When questioned, the patient readily admitted introducing the foreign bodies through the skin and willingly demonstrated the means by which she broke the pins in two and introduced them under the skin. The hospital attendants had had no knowledge of this practice, and it remains a mystery where she acquired the pins. She said she had been carrying on this practice for a good many years at the insistence of the voice of a small boy, claimed by her to be divine. This boy told her she would be "brighter" and would "treat people better" if she introduced the pins. She indicated that she had not introduced any pins for several years because the boy had discontinued talking to her.

Fig. 4. Case 1. Detail of Figure 3, showing characteristic appearance of broken portions of pins, with pointed tip and opposite end usually bent.

Fig. 5. Case II. Portions of needles and safety pins in cervical and mediastinal regions. These objects may have perforated the esophagus in an attempt to swallow them.

On inspection, the skin over the penetrated areas showed punctate discolorations and, on palpation, a peculiar nodular sensation subcutaneously. Surprisingly, there was no evidence of scarring or infection.

Case II. M. T., female, aged forty-five. At the time of admission to one of the state hospitals, her diagnosis was dementia praecox and she was very badly deteriorated. She was often violent and exhibited evidence of sadism. She took delight in attempting to choke other patients with a stocking, always with a smile on her face. She constantly muttered and made unintelligible gutteral noises.

In the course of the first roentgen survey, the miniature chest film showed evidence of foreign bodies (Fig. 5). Re-examination with large films confirmed the presence of many foreign bodies in the thoracic area. Lateral (Fig. 6) and oblique views showed images of portions of safety pins and needles located subcutaneously, anteriorly in the tissues of the neck and upper thorax. There are also portions of fine needles in the mediastinum along the trachea. One needle is located just above the diaphragm near the esophagus.

In addition to these cervical and intrathoracic foreign bodies, there are many portions of needles subcutaneously in the posterior cervical region and overlying the left scapula.

In the face of the patient's inability to give any information as to how these foreign bodies may have reached their present location, one can only speculate on this aspect of the matter. The needles in the anterior chest wall could have been introduced directly by the patient. The needles in the mediastinum could have reached their positions by perforation of either the trachea or esophagus, following attempted ingestion, or, by migration from the cervical region. In this regard, however, repeated roentgen examinations of other patients, over periods of several years, has shown no evidence of migration of foreign bodies at all.

The presence of portions of needles in the left scapular region in this patient is even more difficult to explain. It is presumably possible

Fig. 6. Case II. Lateral view of same case showing mediastinal location of foreign bodies. Also, broken portions of needles in the subcutaneous tissues over one scapula.

for the scapular area to be reached by the patient herself, though this seems unlikely. It is possible that she is also masochistic, as well as sadistic, and that she has induced another patient to introduce needles in her back for the satisfaction which it might afford her.

DISCUSSION

Practically all of the patients in this series had been diagnosed as dementia praecox. Most of them were so badly deteriorated that no idea could be gained regarding a possible motive for the introduction of foreign bodies. Some of the patients exhibited definite sadistic tendencies. Many patients displayed evidence of masochism and this very likely plays an important and perhaps determining role in the practice. One patient, for instance, derives great pleasure from receiving hypodermic injections. Hallucinations, as in Case 1, may well be the impelling cause.

In the general population, it is probable that one should consider the possibility of fraud or deception as a motive. Regan[2] encountered a patient who had been treated for fracture of the humerus by open reduction. This individual later brought suit for malpractice against the hospital where she had been treated, claiming that surgical needles had been left in her arm. A roentgenogram of the arm showed several foreign bodies exactly like the portions of pins shown in Case 1 (Fig. 4), described above. The bend at the blunt end of the pin suggested that the objects were portions of pins and not needles. When the patient's lawyer was apprised of this evidence, the case was dropped. This motive, undoubtedly, was not a factor in the institutional cases described in this report.

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THE MYELOGRAPHIC DIAGNOSIS OF EPIDURAL METASTASES IN THE LUMBOSACRAL SPINAL CANAL*†

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ALTHOUGH the myelographic aspects of herniated dics, tumors of the spinal cord and its coverings and less frequent lesions such as angiomas and epidural abscesses are well known, little is mentioned about epidural metastases. The present report concerns 11 patients with epidural metastases in the lower lumbar spinal canal, most of whom were presumed to have herinated discs. In 4 the myelographic changes could not be distinguished from those present with herniated discs, while the caudal sac in the remaining 7 assumed what appears to be a fairly characteristic malformation.

The relationship between vertebral metastases and spinal cord symptoms is accepted as a commonplace. Nevertheless, direct references to epidural tumor deposits are seldom encountered. According to Dyke[2] tumors arising extradurally form about 20 per cent of all intraspinal growths. He included perineurial fibroblastomas, extradural meningiomas, extradural sarcomas and hemangiomas, idiopathic cysts, dermoids and epidermoids, extradural lipomas, neurofibromatosis lymphomas and deposits due to leukemia. To this list may well be added epidural metastases. Ray[5] lists them among the various types of extradural tumors found at operation. Sachs[6] states that out of 234 verified spinal tumors 58 were malignant. Of these, 20 were metastatic carcinomas, 28 were sarcomas and 10 were gliomas. Further details as to associated skeletal lesions or myelographic defects are not supplied in his résumé. Willis[11] describes metastases to the dura and meninges as relatively infrequent, but does not discuss epidural metastases. Ewing[3] briefly indicates that an extradural position of an intraspinal tumor may be suggested by long-continued Brown-Séquard's paralysis with unilateral root symptoms followed by unilateral medullary symptoms. Verda[10] mentions that malignant lymphomas of the spinal epidural space may arise within the space itself or may migrate from regional lymph nodes. An extradural tumor composed of normal thyroid tissue involving the thoracic spine is reported by Denker and Osborne.[1]

The are a few references to the myelographic demonstration of intraspinal block with epidural metastases. Smith and Stenstrom[7] reported 11 out of 308 cases of Hodgkin's disease with symptoms of spinal cord compression, and operated on 8 of these. Myelography before operation disclosed spinal canal block in 3 cases. Foster and Heublein[4] report a case of hemangioma of the fourth dorsal vertebra with pantopaque block assumed to be due to epidural extension. Surgical verification was not obtained inasmuch as the patient responded to roentgen therapy alone. Compression of the spinal cord by a myeloma of the fourth dorsal vertebra is mentioned by Snyder and Wilhelm,[9] who observed an incomplete block in this region on an air myelogram. While myelography is in frequent use for determining the existence of spinal canal block in patients with spinal metastases, there does not appear to be specific mention as to its further advantage in visualizing nonobstructive intraspinal metastastic tumors, particularly in the lumbosacral region.

The admission diagnosis in 9 of the present 11 cases was herniation of the nucleus pulposus of the lower lumbar spine. In 2 cases the possibility of metastatic disease

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† Aided by the Celia G. Antonoff Memorial Radiologic Research Fund.

was considered because of a known kidney tumor in one and breast tumor in the second. All 11 patients complained of intermittent low back pain of varying intensity and duration, radiating down the leg on one side or the other in 9 instances. In 2 cases bilateral sciatic radiation was noted. At times, the pain had been aggravated by strain. Temporary relief had been obtained from rest and other conservative measures. The duration of symptoms varied from three weeks to one year. Physical examination disclosed absent or diminished ankle or knee jerk reflexes in 10 patients. One had slight hypalgesia and hypesthesia in the saddle area. A positive Lasègue sign was elicted on the effected side in 9 cases. Examination of the cerebrospinal fluid revealed normal protein content in 2 cases, and in 3 the protein content was elevated to between 100 and 125 mg. per cent. Manometric examinations in 8 cases showed no evidence of block.

Plain roentgenograms made before myelography were considered normal in 4 cases. In 2 others there was discussion as to whether a slight decrease in the density of the fifth lumbar or first sacral vertebra indicated metastatic involvement. In 4 cases a lytic lesion in the fifth lumbar or first sacral vertebra had been overlooked, only to be identified on myelograms and on later review of the preceding films. In 1 case the metastatic nature of a very faint decalcification of the body of the fifth lumbar vertebra in its posterosuperior aspect was confirmed by the coexistence of ischial metastases.

Myelography revealed a deformity of the distal end of the pantopaque column of approximately the same type in 7 cases. In these, the caudal sac assumed a tapered appearance resembling an inverted inclined cone of varying height deviated away from the lesion. The ipsilateral axillary pouch at the lumbosacral interspace was blunted or obliterated, while that on the opposite side was either pressed against the pantopaque column or was unidentifiable.

In 2 cases a rather scalloped indentation of the pantopaque column was observed at the interspace between the fourth and fifth lumbar vertebrae. Although considered atypical, these could not be distinguished from defects seen with herniated discs. In the remaining 2 cases, a transverse arrest of the pantopaque was observed at the interspace between the fourth and fifth lumbar vertebrae. This also was interpreted as probably due to a large herniated disc.

Operative confirmation was obtained in 10 cases. The primary growths in the patients with tapered caudal sac defects were found to be fibrosarcomas of the upper sacrum in 2 cases, an angiosarcoma of the upper sacrum in 1 case, so-called "benign metastasizing goiter" in 1 case, and metastases to the lumbosacral interspace from carcinomas of the kidney, sigmoid and stomach accounted for the remaining 3 cases. The case with metastases from the stomach was not verified at operation, but had a definite lytic lesion in the upper sacrum together with roentgen evidence of carcinoma of the stomach which had been unsuspected clinically.

The 2 patients with lateral defects at the interspace between the fourth and fifth lumbar vertebrae were found to have metastases from carcinoma of the breast and lung respectively. The remaining 2 patients with transverse blocks at the interspace between the fourth and fifth lumbar vertebrae had a fibrosarcoma and a myeloma of the fifth lumbar vertebra respectively.

Subsequent roentgen investigation of the bones in these patients showed no other skeletal metastases except in 1 patient, who also had a metastasis to the third dorsal vertebra which was asymptomatic.

In each case the deformities observed on the myelograms were caused by epidural metastases. The deposits of malignant tissue were irregular or nodular in shape and varied in thickness from a few millimeters to 1.5 centimeters in thickness. The nerve roots were found to be deflected by the metastases, and in 2 cases encrustations

of the involved nerve roots by tumor tissue were noted. No dural invasion was found. In 9 cases operative evidence of invasion of bone a short distance from the epidural metastases was found, but no visible direct connections were noted between the osseous malignancies and the epidural deposits. In 1 case (Case 1) of so-called "benign metastasizing goiter" the bone was entirely intact.

The myelographic alterations appeared to be due to the epidural deposits rather than to any visible pathologic distortion of the adjacent bony walls of the spinal canal. Undoubtedly the metastases to the fifth lumbar and first sacral vertebrae from distant sites were hematogenous. The extension of the tumor into the epidural space from these metastases, as well as from the sarcomas of the fifth lumbar and first sacral vertebrae, was probably by way of the vertebral plexus of veins which communicate freely between the epidural space and the vertebrae. This mode of extension should be differentiated from spinal canal encroachment caused by pathologic fractures or direct invasion of tumor into the spinal canal from an adjacent malignancy.

The tapered myelographic defects were observed only at the lumbosacral interspace. This was caused by extension of the epidural metastases from the lumbosacral region into the relatively roomy upper sacral canal. The heaviest parts of the metastases were found in the upper sacral canal. The growth thus deflected the caudal sac contralaterally in a linear manner, producing an inverted conical configuration of the pantopaque column deviated away from the lesion.

When the epidural deposit was limited to the interspace between the fourth and fifth lumbar vertebrae, the pantopaque column was deformed according to the extent and configuration of the deposit. In 1 case the scalloped appearance was rather more pronounced than in the second. The 2 cases with transverse arrest could not be distinguished from block due to other causes, although at operation it was evident that the lateral and transverse defects were caused by large epidural metastases.

REPORT OF CASE

CASE 1. Y.K., a female, aged fifty-nine, had had recurrent episodes of low back pain for ten months. The pain radiated into the right buttock and along the back of the right thigh to the lateral aspect of the heel. During the three months before admission she had also been aware of pain in the left buttock radiating down the left leg. A sensation of pressure in the rectum and a constant desire to void had been present for three weeks before admission. The symptoms had been aggravated by straining and coughing. She had had a thyroidectomy for a benign adenoma six years before admission. A review of the histopathologic sections showed no reason to change this diagnosis.

Physical examination revealed no muscular weaknesses or atrophy. The ankle jerks were absent. The knee jerks were normal. An area of hypesthesia and hypalgesia was outlined in the saddle area. There were no pathologic reflexes. The Lasègue sign was positive bilaterally.

Plain films of the pelvis and lumbosacral spine were normal. Pantopaque myelography revealed a conical tapered appearance of the caudal sac at the lumbosacral interspace, with displacement of the sac from right to left. The axillary pouches did not fill on either side.

The clinical and roentgenologic diagnosis was protrusion of the nucleus pulposus at the lumbosacral interspace on the right.

At operation (Dr. L. M. Davidoff) the lumbosacral interspace was entered on the right side and the nerve root was found to be flattened across a mass which at first was believed to be a large extruded disc. At this point retraction of the dura and nerve root from the surface of the mass revealed it to be a brownish black, solid, almost oval tumor about 1.5 cm. in diameter. The capsule was incised and a moderate amount of darkly pigmented tumor was removed. The tumor was then completely enucleated.

Histopathologic examination revealed well differentiated thyroid tissue with acini filled with colloid. The epithelium was high in some places, but there was no evidence of anaplasia.

The patient received deep roentgen therapy over the lower lumbar spine after operation.

She was given 2,750 r, in air, to a 10 by 15 cm. portal centered over the lumbosacral interspace in seven doses over a three week period. Three months later she was given a second course of 1,500 r. The physical factors were 200 kv., 0.5 mm. copper and 1 mm. aluminium filtration, 50 cm. target-skin distance. At present, two years after operation, she is completely relieved of her symptoms.

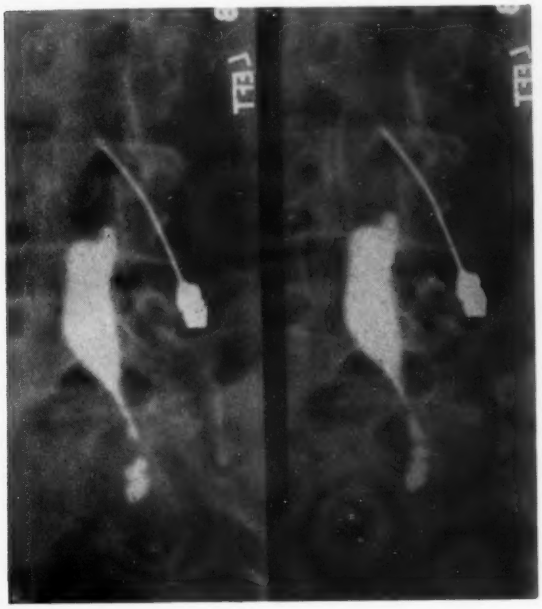

Fig. 1. Case 1. Myelogram taken in the erect position. The caudal sac presents an inverted conical configuration deviated to the left. The axillary pouches at the lumbosacral interspace are not visible. No bony defects were visible on the preliminary roentgenograms or at operation. A "benign metastasizing goiter" implant was removed.

COMMENT

While plain roentgenograms may sometimes indicate the existence of an intraspinal growth by decalcification or erosion of the pedicles, the laminae or the vertebral bodies, it is not at all uncommon for such examinations to be normal. The myelographic demonstration of circular or cap-like configurations associated with some of these lesions is of further help. The myelographic changes observed with herniated discs are well known. Aside from extradural sarcomas, none of these conditions produce the tapered defect described above with epidural metastases to the lumbosacral region.

The 7 cases in which the plain roentgenograms were either normal or showed minimal lytic changes are of particular interest, and re-emphasize the necessity for meticulous technique. Even with films of fine quality it is possible to miss metastatic

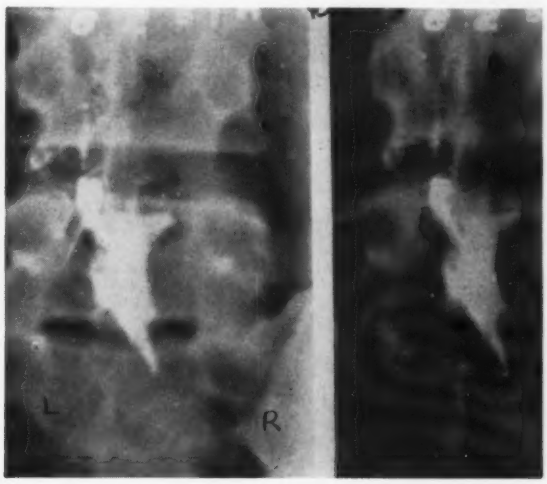

Fig. 2. Myelogram taken in the erect position. The caudal sac is tapered and deviated to the right. The right axillary pouch at the lumbosacral interspace is blunted and slightly elevated; the left is intact. At operation an epidural metastasis from a hypernephroma was found. The preliminary roentgenograms were believed to be within normal limits, although a slight decalcification of the superior aspect of the fifth lumbar vertebra was present.

deposits. As shown by Snure and Maner[8] bone detail on roentgenograms is a factor of the cortex, while the spongiosa accounts for density. A considerable amount of metastases may exist in a vertebra, but no roentgenographic changes can be seen unless either the cortex is involved or sufficient replacement of the spongiosa with tumor has taken place. This probably accounts for the difficulties in roentgenographic interpretation encountered in the present cases.

The extent of metastatic involvement of the vertebrae does not necessarily parallel the patient's complaints. Pain is caused primarily by involvement of the

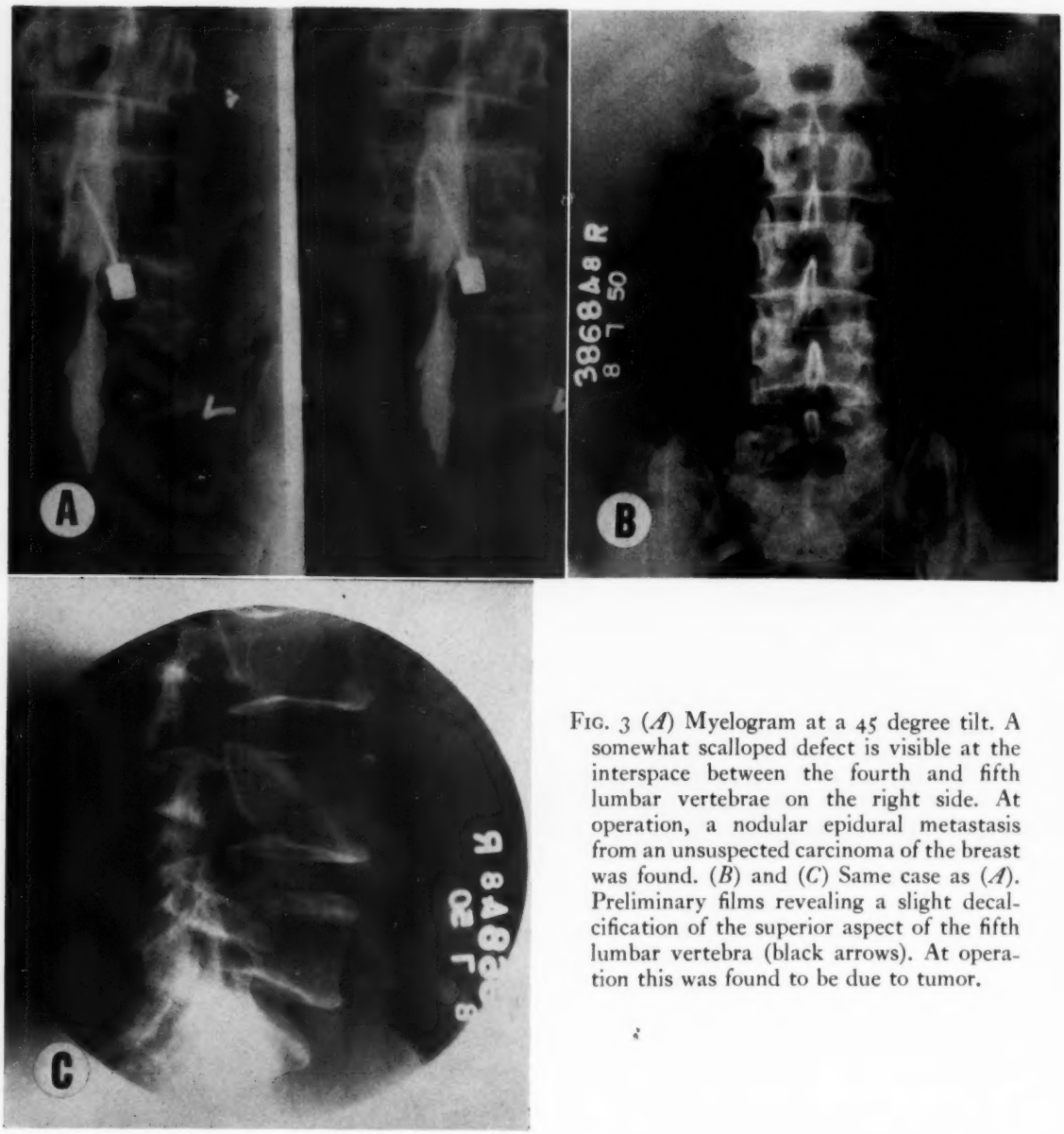

Fig. 3 (*A*) Myelogram at a 45 degree tilt. A somewhat scalloped defect is visible at the interspace between the fourth and fifth lumbar vertebrae on the right side. At operation, a nodular epidural metastasis from an unsuspected carcinoma of the breast was found. (*B*) and (*C*) Same case as (*A*). Preliminary films revealing a slight decalcification of the superior aspect of the fifth lumbar vertebra (black arrows). At operation this was found to be due to tumor.

periosteum and pressure on the spinal cord and nerve roots. If these structures are not compromised there may be extensive metastases and little pain. On the other hand, patients with little or no visible indication of spine metastases may have considerable pain if epidural metastases exert pressure on the cord or nerve roots. If this pain affects the lower back, radiates down the sciatic distribution, and no direct evidence of metastases is found, the clinical picture may simulate a herniated disc. Myelography may help in differential diagnosis in some cases if a tapered, conical configuration of the caudal sac is revealed. In such cases, preliminary trial with roentgen therapy might prove helpful. If the deposit is isolated, the patient might also benefit from decompression and removal of the tumor followed by roentgen therapy.

SUMMARY

Myelographic observations in eleven patients with epidural metastases in the

lumbosacral spinal canal are reported. Clinically, these simulated herniations of the nucleus pulposus. Plain roentgenograms were believed negative or equivocal in six cases. In seven cases a tapered, inverted conical configuration of the caudal sac on myelographic examination accompanied lumbosacral epidural deposits. When the metastases were situated above the lumbosacral interspace, the myelograms presented defects which could not be differentiated from those existent with herniated discs.

An unusual case of lumbosacral epidural metastases from a so-called "benign metastasizing goiter" is reported. In this patient no bony disturbances were found either at operation or on roentgenologic examination, and the epidural deposit was probably hematogenous in origin.

In the remaining cases, it was believed that the metastases extended to the epidural space from the vertebral malignancies by way of the epidural-vertebral complex of veins.

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HIP JOINT ARTHROGRAPHY*

By GILBERT W. HEUBLEIN, M.D., GERALD S. GREENE, M.D., *and* VICTOR P. CONFORTI, M.D.

OPAQUE arthrography of the hip joint is often valuable in solving selected orthopedic problems of children. Severin,[10–14] Leveuf,[7,8] and others,[1,2,6] in articles published mainly abroad, and occasionally in our own journals, have completely reviewed the literature, and provided the stimulus for our present investigation.

One can hardly approach this subject without recognizing the outstanding contributions of Severin,[10–14] who stresses that a large proportion of the infant's hip joint is cartilaginous. Even the adult joint is not completely ossified. Conventional roentgenograms, prior to six to eight months of age, afford little or no information regarding the radiolucent cartilaginous portions of the hip joint or such intrinsic soft tissue structures as the limbus, ligamentum teres, or synovium. In cases where the ossific capital nucleus is not demonstrated by roentgen study, it is sometimes impossible to tell whether or not one is dealing with luxation, subluxation or a normally conjugated femoral head. A case in point recently observed in our clinic is that of a coxa vara deformity of the unossified proximal femur which led several competent observers to make the erroneous diagnosis of dislocation, inasmuch as the femoral metaphysis seemed to lie lateral to its normal position. Subsequent arthrographic studies revealed normal relationship of the femoral head to the hip socket.

The case against plain roentgenograms is aptly summarized by Deutschländer.[1] "Roentgen study is of prime importance in critical evaluation of the relation of the capital epiphysis to the acetabulum. Unfortunately, this medium falls short in young children due to the fact that the upper portions of the acetabulum are cartilaginous and generally late in ossification. This state of affairs often leads to faulty interpretation, and reports of satisfactory reductions are rendered when in actuality the reductions are poor."

Although satisfactory postmortem aerograms were obtained as early as 1908 (Gocht[13]), it was not until relatively recently that the roentgen features of the normal and dislocated hip were completely described by Severin.[12] This author stresses the importance of identifying the exact position of the free border of the cartilaginous acetabulum, otherwise known as a labrum glenodale or limbus spine. In the normal joint the following criteria must be met (Faber):[2,9,13]

1. The cartilaginous spine must lie at or close to the Y-line.
2. At least one-half the spherical femoral head should be clasped by the cartilaginous socket.
3. No wide band of contrast material should lie pooled between the femoral head and the floor of the hip socket.
4. A line extending between the limbus spine above, downwards and medially to the impression of the round ligament indicates the position of the free border of the cartilaginous socket.

In *subluxation* the limbus is gradually pressed upwards above the Y-line as the head migrates laterocephalically. Finally, the head lies free, *completely dislocated*, the limbus being interposed between it and the mount of the acetabulum. In this position the limbus frequently hypertrophies presenting a barrier to reduction. Arthrography, therefore, allows for more accurate differentiation between subluxation and dislocation.[7]

ROENTGEN ANATOMY

Important morphological features which are discernible by arthrography in normal and abnormal joints include the following:

* From the Newington Home and Hospital for Crippled Children, Newington, Connecticut.

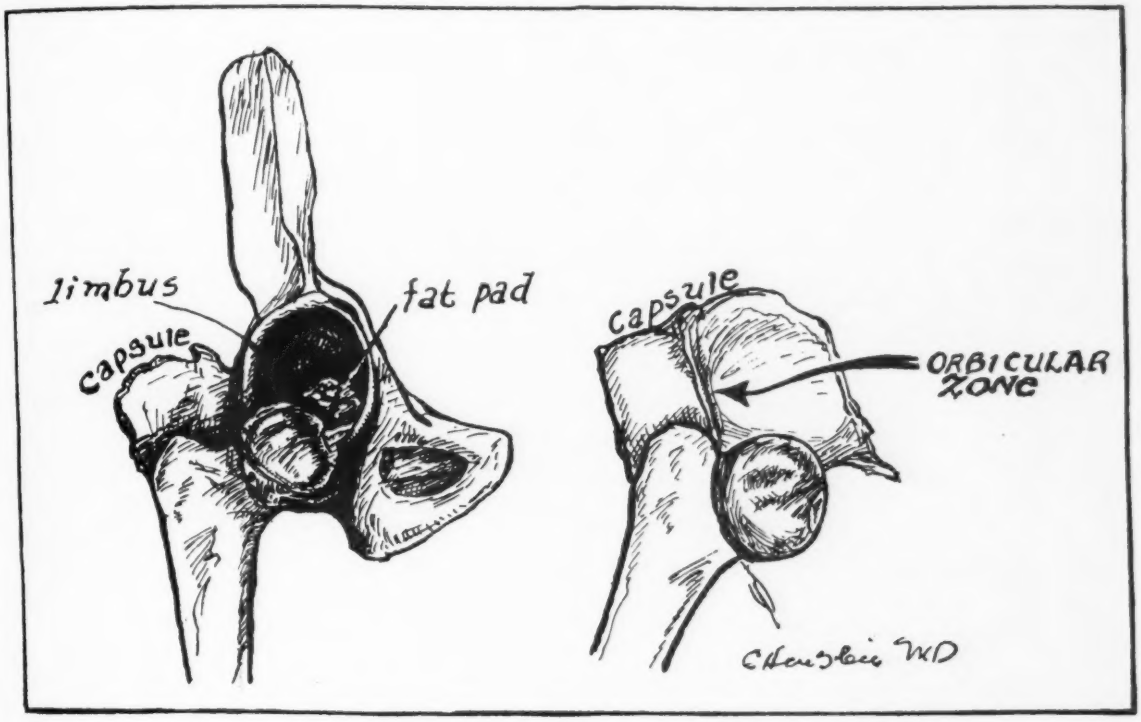

Fig. 1. Dissection of stillborn infant's right hip showing important anatomical structures. Note the prominent limbus, and well developed fat pad and ligamentum teres. The unimpressive orbicular zone shown on the right is much more prominent in arthrographic studies (see Fig. 2). Dissection by Dr. Conforti.

(1) *In Normal Hips*

1. Femoral head—slight variation in size and shape such as hypo- and hyperplasia or other variant.
2. The limbus or acetabular lip.
3. Orbicular zone (zona orbicularis)—a localized thickening of circular fibers reinforcing the hip joint capsule. It will be noted that this structure divides the opaque medium into two parts, and appears as a radiolucent zone surrounding the femoral neck (Fig. 1 and 2).
4. The transverse ligament discernible as a small indentation in the opaque medium inferomesially (Fig. 2).
5. In the normal hip the ligamentum teres cannot be identified. However, its site of origin is marked by two small prongs of contrast medium projecting downwards and medially into the acetabular fat pad. These were first described by Severin,[12] who named them the "ventral and dorsal recesses of the acetabular fossa" (Fig. 3).

(2) *In Abnormal Hips*

1. In congenital dislocations the ligamentum teres may become hypertrophied, appearing as a ribbon-like shadow coiled on the acetabular side of the deformed hour-glass capsule.
2. Narrow hour-glass constriction of the capsule in congenital dislocation ("isthme très étroit" of the French).
3. The presence of adhesions between the capsule and ilium (Kidner[4,5]) or evidence of paracephalic adhesions (Leveuf[8]).
4. Partial or complete destruction of the femoral head or neck in coxitis.
5. Hip joint incongruity in Legg-Perthes disease.

TECHNIQUE AT NEWINGTON

The technique of arthrography is more easily described than accomplished. The best approach is anterior. The skin is prepared and draped in the usual manner. In children, general anesthesia is essential.

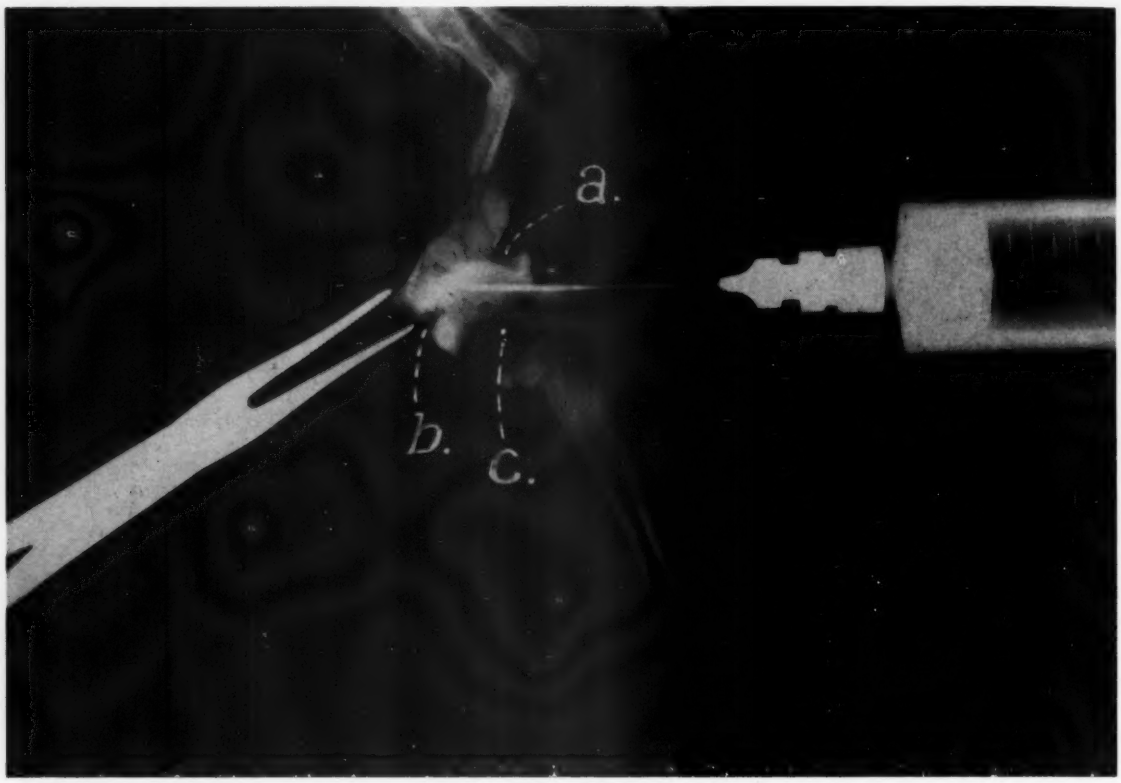

FIG. 2. Injection of normal right hip of stillborn infant showing limbus at "*a*," orbicular zone at "*b*," and site of transverse ligament at "*c*." Injection by Dr. Conforti.

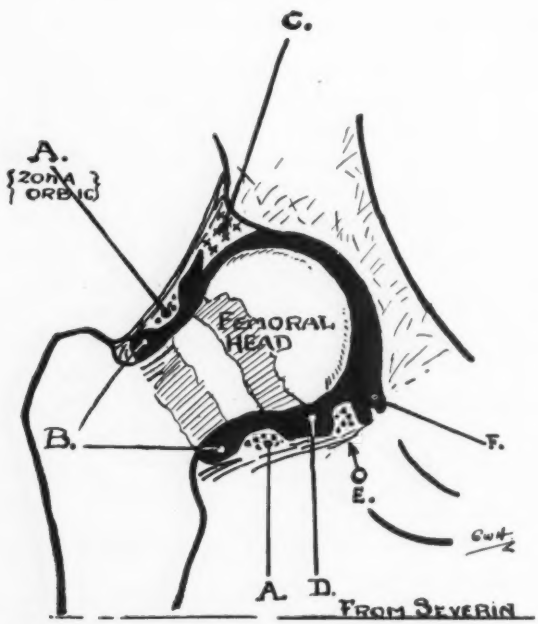

FIG. 3. Right hip joint slightly modified from Severin. (A) Zone orbicularis. (B) Contrast pool lateral to orbicular ligament. (C) Cartilaginous limbus. (D) Contrast pool medial to orbicular ligament. (E) Ligamentum transversum. (F) Ventromedial and dorsolateral contrast plugs.

It is difficult to enter the joint of a struggling child, and there is danger of the needle breaking. With the child asleep—the level of anesthesia need not be particularly deep—the femoral artery is palpated below Poupart's ligament. A short-beveled spinal puncture needle, No. 19 or 20, is then inserted one finger's breadth lateral to the femoral artery, one finger's breadth distal to Poupart's ligament. When the needle point strikes bone, the leg is rotated. The surgeon can thus determine whether the needle is in contact with the femur or acetabular rim. Very often, he can actually feel the cartilage of the femoral head rotating beneath the needle. At this time 2 to 3 cc. of normal saline are injected. If the saline is in proper position within the capsule, it will be possible to withdraw the

Fig. 4*A*. Case 1. B.W. Admitted: Newington Home and Hospital July 6, 1948. Bilateral dislocated hips first noted at three months. Note wide spacing of trochanters in lower illustration and disruption of Shenton's lines. Multiple manipulations and castings failed to reduce the deformities. Upper illustration shows almost total lack of information obtained by film through heavy spica. Occasionally carefully supervised laminagraphic studies may be informative in evaluating dislocations through such heavy plaster. Subsequent arthrograms (Fig. 4*B*) indicated the advisability of open reduction.

injected fluid. If not, further attempts are made to find the capsule. When the joint has been entered, 3 to 5 cc. of a 17.5 per cent diodrast solution is injected and films secured. Excess diodrast is then withdrawn and additional films are taken immediately. It has been pointed out by one of us (V.P.C.) that the second set of roentgenograms is particularly valuable, affording rather more information regarding the status of the hip joint and cartilaginous femoral head. If closed reduction of the luxated hip is contemplated, 2 to 3 cc. of diodrast solution is allowed to remain in the joint, and further roentgenographic study is obtained following reduction.

Fortunately, diodrast is absorbed rather rapidly both from the joint itself and, in the event of extravasation, from the surrounding soft tissues. A film made twenty to twenty-five minutes after injection will reveal no significant opaque residue (Fig. 6*C* and 8*C*). Where arthrotomy has been undertaken, subsequent to diodrast arthrography, no evidence of irritation of the synovial lining by the contrast medium has been found. Our observations parallel those with opaque venography of the lower extremities. None of the patients so far examined have experienced any untoward constitutional reaction from this procedure. In support of this Leveuf and Bertrand[6] state: "No articular reaction has been observed after the procedure which appears to us, as to others, entirely harmless."

CASE REPORTS

Case 1. B. W. (Fig. 4*A* and 4*B*). Birth date: January 24, 1948.

This patient was admitted July 6, 1948, with bilateral dislocations of the hip. This was de-

FIG. 4*B*. Case I. B.W. Arthrograms (August 11, 1948) showing bilateral isthmic defects. An interposed cartilaginous limbus is noted at "*a*." Hour-glass defects obviously present complete barrier to closed reduction. After open reduction hips were reduced. Postoperative course was uneventful.

tected at the age of three months by the patient's local physician.

Physical Examination. The trochanters were widely spaced with marked constriction of the adductors. Two attempts at closed reduction met with failure due, apparently, to the contracted adductor muscles (July 8, 1948, July 28, 1948).

On August 11 arthrograms revealed bilateral hour-glass deformities with constricted isthmic defects which obviously presented a barrier to complete reduction.

On September 15 and October 20 respectively, the right and left hips were reduced by open reduction.

On December 22, the original spica was removed, the wounds were found to be well healed, and the postoperative course was uneventful.

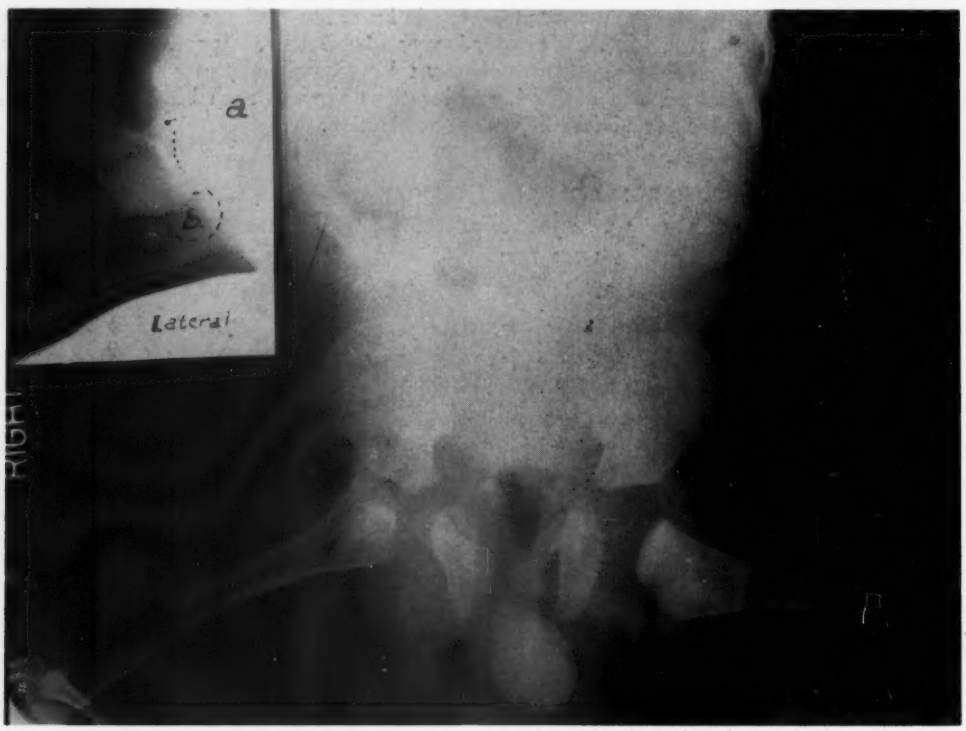

FIG. 5*A*. Case II. J.R. Admitted September 27, 1948, at five months of age showing recurrent dislocation of right hip. Note high and posterior position of right femoral neck. Insert shows ventral spur, not to be confused with femoral neck, at "*a*," and approximate position of femoral head at "*b*." History of hematoma of right hip at birth.

Case II. J. R. (Fig. 5*A* and 5*B*). Birth date: April 25, 1948.

This patient was admitted September 27, 1948, with a diagnosis of congenital dislocation of the right hip. History revealed that following birth the infant was observed to have a hematoma of the right hip. There was restriction of motility of the hip according to the mother. Roentgenograms at that time revealed a dislocation of the right hip. This was "reduced" and maintained in frog-leg position for several months. On re-application of the cast, because of the growth of the child, it became evident that the dislocation had recurred.

On physical examination at the time of admission, the right gluteal fold was noticeably deeper than the left. There was atrophy and limitation of abduction of both lower extremities.

Arthrography on September 29, 1948, revealed an hour-glass deformity of the capsule, severe enough to prevent reduction. On October 13, 1948, the right hip was exposed and the dislocation reduced. A bifid femoral head was found. The postoperative course was uneventful. Laminagraphic studies subsequently showed the right capital epiphysis in normal position, and the patient was discharged to the out-patient clinic—condition improved.

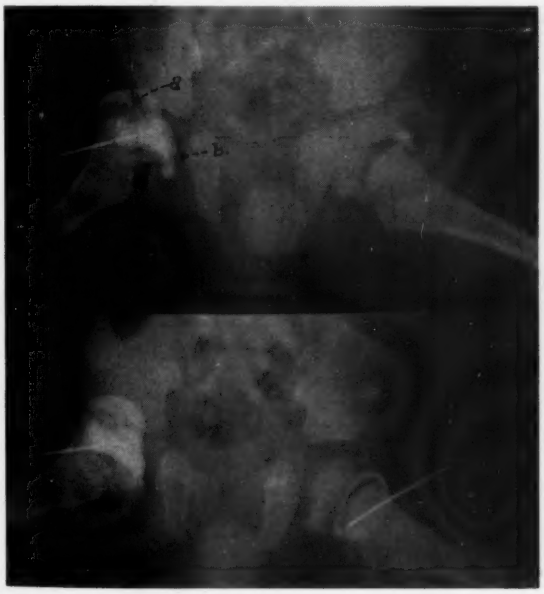

Fig. 5*B*. Case II. J.R. Arthrograms made on September 29, 1948, showing bifid femoral head at "*a*," an isthmic defect preventing reduction at "*b*," and small ventral spur at "*c*." The bifid capital femoral epiphysis was found and the dislocation reduced. Postoperative course and follow-up were uneventful.

Fig. 6*A*. Case III. J.A.W. Admitted December 3, 1948, to Newington Home and Hospital. Pediatrician's diagnosis of congenital dislocation of left hip at birth confirmed by survey roentgenogram above which shows marked slope of left acetabular roof and high, lateral position of the left capital epiphysis.

Case III. J. A. W. Birth date: August 6, 1948. Admitted on December 3, 1948, to the Newington Home and Hospital.

At birth bilateral club feet and a dislocated left hip were noted. This clinical finding was confirmed on December 3, 1948, in the Newington Home and Hospital for Crippled Children. Under anesthesia the left hip was reduced, arthrograms were obtained, and the legs placed in frog-leg position. A spica was applied and the patient discharged to her home. She was subsequently returned for admission to our hospital as follow-up on the outside was found to be unsatisfactory. The left capital epiphysis remained in good position. Her hospital course

FIG. 6*B*. Case III. J.A.W. Arthrogram showing reduction of left hip under anesthesia and satisfactory position of the capital epiphysis. The hypertrophied limbus, indicating dislocation rather than subluxation, is shown at the arrow. In subsequent figures note the wide contrast pool between femoral head and acetabular floor. This disappears as the legs are abducted (Fig. 6*C*).

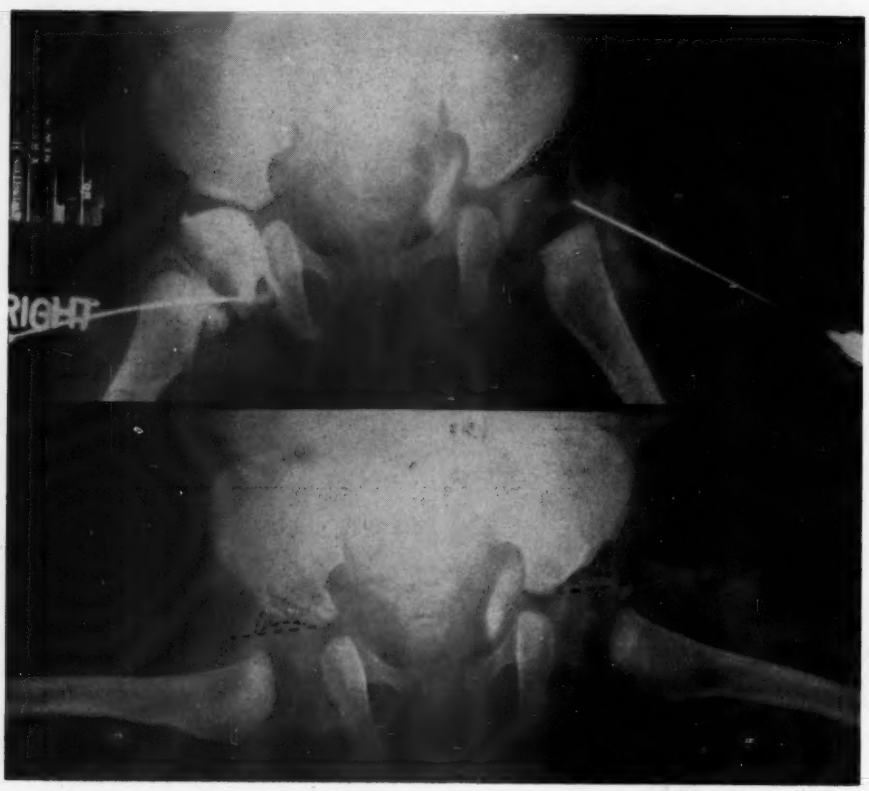

FIG. 6*C*. Case III. J.A.W. Showing value of delayed roentgenograms in evaluating the cartilaginous limbus and reduction of left hip with normal right side for comparison. Note the slight extravasation in the soft parts has disappeared almost completely by the time the delayed film was made.

was essentially that of changing the double hip spica and plaster casts with wedging for correction of a persistent convex pes valgus, which was resistant.

In November, 1949, additional roentgenograms revealed the left hip remaining in good position and she was ultimately referred to Dr. E. Coughlin of Williamstown, Massachusetts, for follow-up and treatment (Fig. 6*A*, 6*B* and 6*C*).

Case iv. A. N. Birth date: August 16, 1947. This patient was admitted to the Newington Home and Hospital for Crippled Children on February 9, 1948, for treatment of bilateral club feet and dislocated left hip.

Past History. There was a history of premature birth at seven and a half months. The child weighed 4¾ pounds. Postnatal condition was poor. During the first four months of life, the infant was treated for club-foot deformity with casts. At the age of two months an infection of the left hip developed, necessitating incision and drainage in September, 1947. At that time, roentgenograms revealed a dislocated left hip. Culture showed *Staphylococcus aureus.*

Physical Examination. Athetoid movements of the left hand and increased muscle tone of the extremities were noted. The left leg was held in a position of external rotation, and was shorter than the right. There was a ¾ inch scar below the left trochanters.

The patient was treated by traction. Aspiration of the left hip was done, but no fluid was obtained. Multiple attempts at closed reduction were unsuccessful, until on September 16, 1948, arthrograms revealed an absent femoral head and a hazy, constricted capsule. On January 6, 1949, the left hip was explored and the roentgen findings were substantiated. The capsule was markedly thickened. No cartilage was found in the acetabulum and the femoral head and neck had been destroyed. The acetabulum was deep. The greater trochanter was placed within it to stabilize the extremity. The patient was discharged to the clinic with

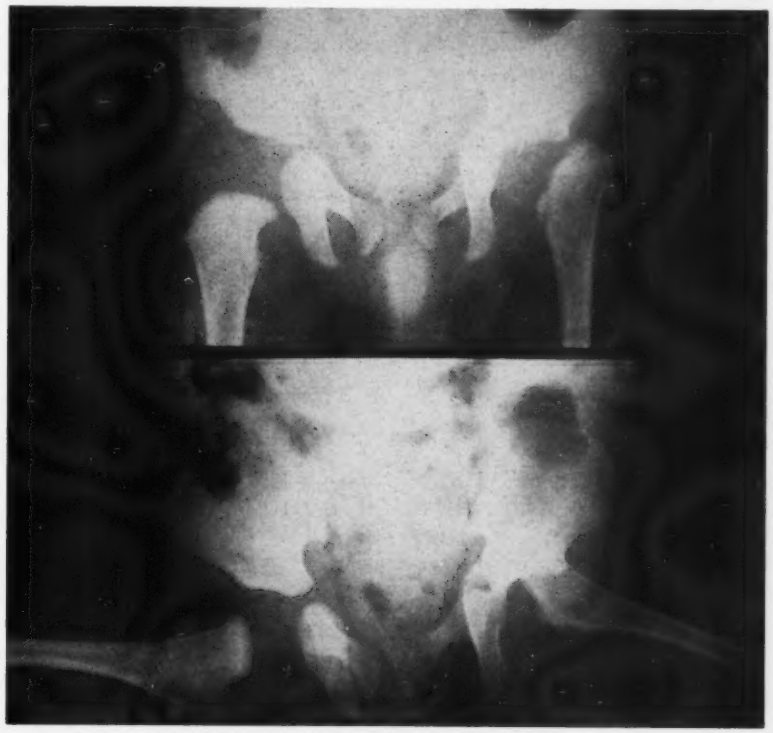

Fig. 7*A.* Case iv. A.N. Admitted February 9, 1948. History of premature delivery followed by left coxitis by *Staphylococcus aureus* at two months. Note gouged-out acetabulum and practically complete obliteration of y-cartilage due to infection. Dislocation is obvious. Patient was treated for several months with traction and manipulations before arthrograms were obtained.

FIG. 7*B*. Case IV. A.N. Normal right arthrogram for comparison with opposite side. Pathological dislocation on left (note Fig. 7*C*).

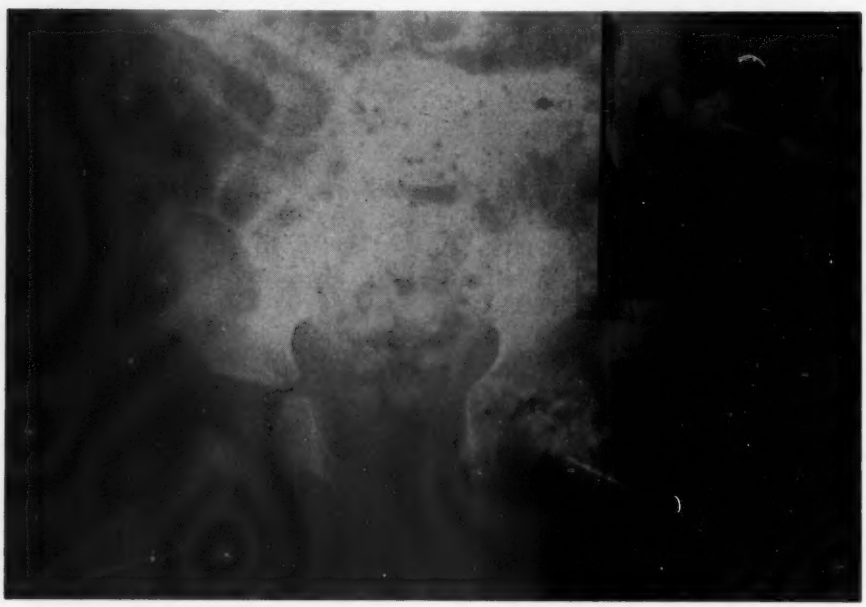

FIG. 7*C*. Case IV. A.N. Note absence of femoral head and neck and markedly contracted capsule. At exploration on January 6, 1949, it was found that head and neck with all the cartilage in the acetabulum were destroyed. The capsule was thickened and deformed by scar. This arthrographic finding provides valuable information that may prevent unnecessary and continued unsuccessful attempts at closed reduction.

Dennis-Brown splints with a short left leg showing good motion except in adduction (Fig. 7*A*, 7*B* and 7*C*).

CASE V. L. E. (Fig. 8*A*, 8*B* and 8*C*). Birth date: January 1, 1949.

This four months old colored infant was admitted May 18, 1949, with the chief complaint of a short right leg. As he developed, it was also noted that the right leg was not used normally. He was seen in the out-patient department where the roentgen diagnosis of subluxation of this hip was rendered.

Physical Examination. This revealed shorten-

ing of the right leg of approximately 1⅝ inches. On May 20, 1949, arthrograms, surprisingly enough, showed no luxation, but a coxa vara deformity plus a possible healed fracture of intrauterine origin.

Final Diagnosis. Coxa vara deformity—old fracture of the right femur, upper third, resulting in shortening of the right lower extremity.

ORTHOPEDIC COMMENT

Arthrography of the hip joint probably finds its widest application in the treatment of congenital dislocation of the hip. One must first determine whether the hip is subluxated or dislocated, and after manipulation it is possible to determine accurately whether or not reduction was successful. The ability to visualize the femoral head in relation to the acetabulum, plus the tactile sensation of stability as determined by the orthopedic surgeon determines the future course of treatment. Arthrography takes the guess-work out of closed reductions of congenitally dislocated hips. Having visualized the femoral head within the acetabulum, and knowing the relationship between these structures, the surgeon is better able to accurately estimate the necessary length of plaster immobilization or may even select some form of abduction splint. There is a general consistency in published figures on the over-all poor end results with old methods of closed reduction and prolonged immobilization. Because of these results, the trend has been to early mobilization, which, however, should never be done unless one is sure that the hip is truly reduced. More recently, we have undertaken arthrography in Legg-Perthes disease. As might be expected, there is no absolute relationship between the shape of the capital femoral epiphysis and the cartilaginous femoral head. What we hope to determine is how much return-to-normal can be expected in the already deformed femoral head with our present methods of treatment. Therapy for osteochondropathy of the hip in this institution consists of immobilization by Wu-splint from time of diagnosis until such time as the roentgen examination shows satisfactory regeneration of the capital epiphysis (Pike).[9]

Fig. 8*A*. Case v. L.E. Admitted to Newington Home and Hospital April 18, 1949. Diagnostic problem. Note the right acetabular roof with angle of acclivity of 36° at five months of age. Is the right hip dislocated? Child has had a short right leg since birth. It was evident that he did not use the right leg normally. Plain roentgenograms were interpreted as showing luxation of the hip.

We have not, as yet, examined a sufficient number of cases of septic arthritis with or without luxation or subluxation to reach any final conclusion regarding this entity. However, where done, arthrography provides valuable information regarding the size, shape and position of the intracapsular soft tissues and cartilage. Extensive cartilaginous destruction is sometimes revealed in this manner. We have

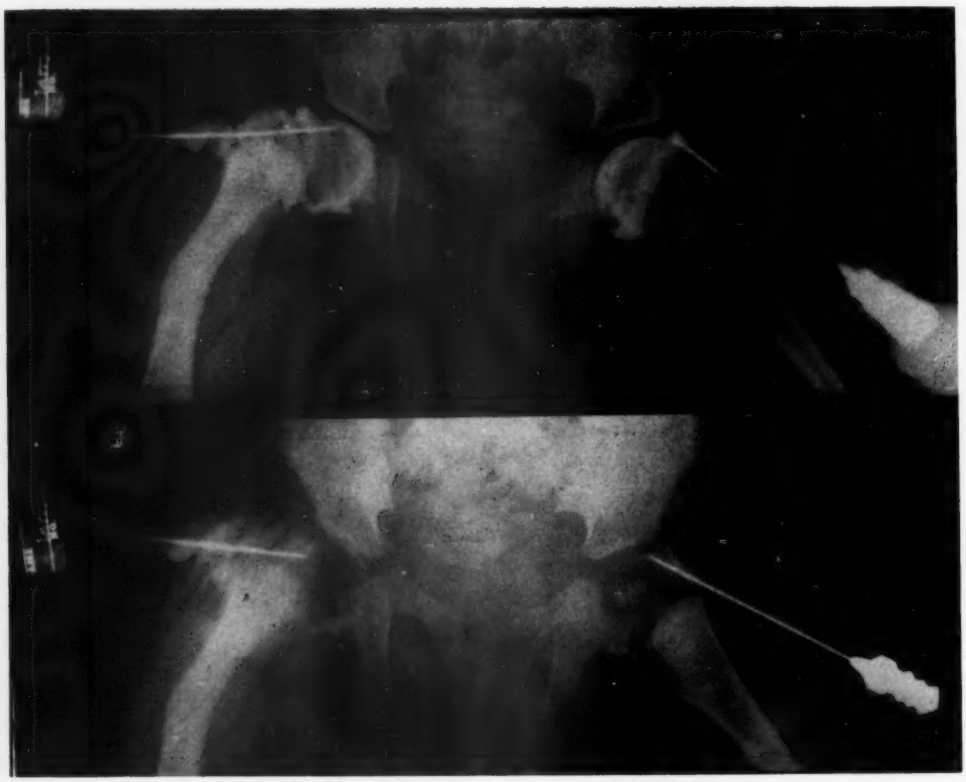

FIG. 8*B*. Case v. L.E. Arthrograms show normal position of cartilaginous femoral head in the hip socket. There is evidence of a congenital coxa vara deformity. The angulation of the right femoral shaft may be explained on a congenital basis or a healed intrauterine fracture.

FIG. 8*C*. Case v. L.E. Delayed roentgenogram showing rapid absorption of extravasated diodrast.

no good answer for the treatment of this unhappy condition, but feel relatively certain that arthrography, when properly used, will protect the patient and save him from much aimless and very often useless therapy. Severin[14] sums up his experience with this condition in the following manner:

> Before any attempt at reduction is made in a case of suspected subluxation or dislocation following an attack of acute infectious arthritis of the hip, the position in the joint must be clearly diagnosed. This offers no difficulties in older children, but in infants, in whom the capital epiphysis of the affected hip is not yet observable by Roentgen, an arthrogram should be taken.

The author suggests that the process should be quiescent for at least six months prior to such a procedure in order to avoid recurrence of the inflammatory process. Should the patient be seen before this time, provisional reduction of the hip is indicated. Subsequent treatment can then be determined by arthrography.

ROENTGEN TECHNIQUE

In previous communications[3] attention has been directed to the excellent quality of film obtained with the Morgan meter and Morgan-Hodges phototimer. In portable techniques without a meter or phototimer, we use 10 ma-sec. with kv. (peak) determined by the formula: centimeter thickness $\times 2 + 24$, the distance is approximately 24 inches without cone or Bucky. In the operating room we employ a 30 ma., 80 kv. (peak) self-rectified mobile unit* with a CYSL Machlett type B-tube (2.3 mm. focal spot). Whenever possible frog-leg postion is used to secure a lateral roentgenogram. If this is impossible a supplementary portable self-rectified 15 ma., 80 kv. (peak) machine† with special operating table attachment is set up to obtain an almost simultaneous lateral exposure. This obviates the necessity of moving the larger unit into a new position. In this projection the central ray parallels the table top passing under the normal leg in the direction of the adductor surface of the affected thigh.

* Keleket.
† G. E. Model F., Type 4.

CONCLUSIONS

1. In selected cases diodrast arthrography of the hip in young children is a harmless and valuable procedure.
2. Since June 2, 1948, forty cases have been examined in this manner without constitutional reaction or unusual sequelae. This type of examination is more informative than conventional roentgen studies in infants where the acetabulum and femoral head are still unossified.
3. Maximum information regarding the cartilaginous and ligamentous structures may be obtained; extent of soft tissue interpositions may be determined, and indications for open or closed reduction more clearly defined.
4. In diagnostic problems such as old coxitis or congenitally hypoplastic lower extremity, arthrography may prove helpful in modifying the form and extent of orthopedic treatment.

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The authors desire to express sincere thanks for the help and interest of their colleagues of the Newington Home and Hospital staff, to Dr. Louis Bernstein for translation of articles, and Mr. Roland Dufresne for his help with photography.

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Vol. 68, No. 5

SECOND-DAY PNEUMOENCEPHALOGRAPHY

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SECOND-DAY pneumoencephalography has been performed for the past fifteen years. Pneumoencephalography is the taking of roentgenograms of an air-filled ventricular system of the brain and second-day pneumoencephalography is the taking of identical roentgenograms on the day following pneumoencephalography. Through the changes in the size and shape of the ventricles, various diagnoses of brain lesions can be made.

There seems to be a controversy in the literature as to what happens to the ventricles on the second day. Paul and Erickson[6] found that the ventricles decreased in size on the second day. Davidoff and Dyke[1] showed that there was no enlargement on the second-day pneucoencephalogram. Evans[3] showed that the ventricles enlarged on the second day. The work of the above authors has all been reported on brains that were either traumatized or that had some organic lesion.

In 1947, Schatzki, Baxter and Troland[8] reported on the second-day pneumoencephalogram with particular reference to the size of the ventricles. They concluded that there could be no doubt that the ventricles were larger on the second day. Their series was reported on patients with organic or traumatic lesions.

All of the above authors reported on patients with a history of trauma or some type of organic disease and none had a control group. The pneumoencephalograms in the present series of cases were done on psychotic patients as a routine procedure to rule out organic brain damage prior to a prefrontal lobotomy, with the exception of 22 cases which were done for diagnostic purposes and these patients gave a history of organic disease or trauma to the brain.

The main purpose of this paper is to present a study of second-day pneumoencephalography to add to the group of cases already in the literature and to add a group of cases in which the brain and ventricular system is relatively normal, according to present day theories of the etiology of psychoses. None of the series in the past that were reviewed consisted of encephalograms done on patients for purposes other than to diagnose some organic or traumatic lesion. This series presents 51 cases in which pneumoencephalograms were done on apparently normal brains.

MATERIAL AND METHODS

A standard routine in performing this operation was carried out with some variations due to the condition of the patient, but these latter cases were rare. Each patient received seconal, grains 1½, at bedtime. This was repeated the following morning with atropine, grains 1/150, hypodermically one-half hour before encephalography. For extremely hyperactive patients chloral hydrate, grains 15, was given fifteen minutes prior to encephalography and in 2 patients a general anesthetic of sodium pentothal was administered.

The patient was then placed on a movable stretcher with his head and arms resting on a table of suitable height before him. One physician repeatedly checked the patient's blood pressure, pulse, respirations and general physical condition, while another performed the operation.

A spinal puncture with the aid of a local anesthetic was performed at the level of the fourth lumbar vertebra, and an initial spinal fluid pressure taken. If the pressure was elevated, with the patient in the sitting position, beyond 500 mm. of fluid, the procedure was discontinued. Next, a four-way stopcock was attached to the needle with one side connected to the air filter, the second side connected to an Erlenmeyer flask for collection of the fluid, and the

third side attached to a 10 cc. syringe for the injection of air and the removal of fluid.

An initial 5 cc. of air was injected, followed by the removal of 10 cc. of fluid and then the injection of 10 cc. of air. Care was taken in withdrawing the spinal fluid not to pull on the plunger of the syringe, but to permit the pressure of the spinal fluid to force the plunger out to fill the syringe. This procedure was repeated until 100 cc. of spinal fluid was removed and 105 cc. of air was injected. The spinal needle was removed and with the patient in the upright position, an anteroposterior, posteroanterior, and a right lateral roentgenogram were taken with the roentgen tube 33 inches from the film. The patient was then returned to bed and twenty-four hours later identical roentgenograms were taken.

Postoperative medication consisted of an oxygen tent for cyanosis or increased respirations for two to six hours, depending upon the condition of the patient, and aspirin, gr. 10 and codeine gr. ½, every four hours as needed for headache. The patient was placed flat in bed for the first four hours, followed by a semi-sitting position. An ice cap was placed to the head as needed for headache.

MEASUREMENTS

In keeping with the technique as devised by Schatzki, Baxter and Troland[8] and in order to facilitate the comparison of their findings with our own, identical linear measurements were made. Using the posteroanterior projection, the first measurement was made from the superior medial corner of the ventricle, perpendicular to the septum, to its lateral border. The second measurement was made from the superior medial border of the lateral ventricle at an angle of approximately 30 degrees from the perpendicular measurement, to the convex border of the lateral ventricle. The third measurement was taken from the superior medial corner of the lateral ventricle along the same line as that of the second measurement but continuing beyond to the concave lateral wall of the anterior horn. These measurements were made for both the right and the left lateral ventricles on the roentgenograms on the day of the encephalogram and again on the twenty-four hour films (Fig. 1).

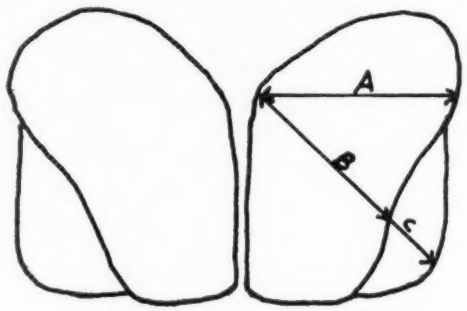

Fig. 1. Posteroanterior view of ventricles showing method of linear measurement. See text for detailed description.

Each determination was recorded separately and the difference between the measurements on the day of the encephalogram and its twenty-four hour film was recorded in centimeters as to increase, decrease or no change. The resulting measurements were plotted. The arithmetic mean was determined as was the standard error, and calculations were performed in order to determine the significance of the results. From these data the final results were determined.

In order to make the work more exacting, it was decided to compare the total area of the ventricles on the films of the day of the encephalogram with the area of the twenty-four hour films. In order to do this a planimeter was used to outline the ventricles on the posteroanterior roentgenograms and the results tabulated in square inches, this being the unit of the instrument. There was no direct comparison between the series of linear measurement and the series of square measurement, so the use of the centimeter in one series and the square inch in the other made no difference in the final results.

RESULTS

There was a total of 73 cases, of which 51, or 70 per cent, were psychotic patients

without a history of trauma or organic disease of the brain. Fifteen cases, or 20 per cent, presented a history of trauma to the brain, all having received closed head injuries. Seven cases, or 10 per cent gave a history of organic disease, including several cases of idiopathic epilepsy (see Table I).

TABLE I

COMPARISON OF CASES

Type of Case	Number of Cases	Per Cent
Psychotic patients	51	69.8
Traumatic patients	15	20.5
Organic patients	7	9.6
Total	73	

Of the 73 cases, 16, or 22 per cent, showed no filling of the ventricular system. To subdivide this group which demonstrates no filling, 12 of them, or 75 per cent, were in the psychotic group, 3 cases or 18.7 per cent, gave a history of trauma, and 1 case, or 6.2 per cent, presented evidence of organic disease. No reason for the non-filling of the ventricles could be determined from this series since a standard technique was used throughout and in none of these cases was any pathology found (see Table II).

TABLE II

CASES WITH NO VENTRICULAR FILLING

Type of Case	Number of Cases	Per Cent
Psychotic patients	12	75.0
Traumatic patients	3	18.7
Organic patients	1	6.2
Total	16—22%	

A comparison of the arithmetic mean of each of the three groups in which there was ventricular filling, the psychotic, the traumatic and the organic, was made. There was an over-all increase in the arithmetic mean on the twenty-four hour film in the psychotic group of 0.26 cm., in the traumatic group there was an increase of 0.31 cm., and in the organic group there was an increase of 0.28 cm. (see Table III).

TABLE III

COMPARISON OF THE ARITHMETIC MEAN

Type of Case	Increase in the Arithmetic Mean—Linear Measurement
	cm.
Psychotic patient	0.26
Traumatic patient	0.31
Organic patient	0.28

It would appear from the findings that those cases which gave a history of trauma to the head presented the greatest increase in ventricular size on the twenty-four hour roentgenograms. Those with a history of organic disease showed the next greatest increase and those with a purely psychotic diagnosis demonstrated the least amount of ventricular enlargement. These figures are all very close and it is doubtful if this difference means too much.

The actual increase in size of all measurements was not found to be significant. The average increase in size of the ventricular system on the second day was 0.31 cm. It must be understood from these figures that it represents the average enlargement, some of the cases actually decreased while others showed a marked increase in size (see Tables IV and V).

The comparison of the data obtained from the total surface area of the ventricular system was next determined. The

TABLE IV

THE ARITHMETIC MEAN OF THE LINEAR MEASUREMENTS OF THE VENTRICLES

Measurement (see text)	*Right Side*		*Left Side*	
	Day	24 hour	Day	24 hour
	cm.	cm.	cm.	cm.
A	1.68	1.97	1.81	2.17
B	1.50	1.75	1.57	1.84
C	2.09	2.50	2.32	2.63

TABLE V

THE DIFFERENCE IN THE ARITHMETIC MEAN OF THE LINEAR MEASUREMENTS OF THE VENTRICLES

Measurement	Right Side	Average	Left Side	Average
	cm.	cm.	cm.	cm.
A	plus 0.29	plus 0.32	plus 0.36	plus 0.31
B	plus 0.25		plus 0.27	
C	plus 0.41		plus 0.31	

arithmetic mean of the left and right ventricles was found for the data of the day of the encephalogram and for the twenty-four hour film. These data were tabulated and the results analyzed to determine if there was any significance in the statistics obtained, there was none (see Table VI).

TABLE VI

ARITHMETIC MEAN WITH THE USE OF THE PLANIMETER

Side	Day	24 Hour	Difference
	sq. in.	sq. in.	sq. in.
Right	0.902	1.092	0.190
Left	1.004	1.183	0.179

There was an increase of 0.19 sq. in. in the area of the right ventricles and an increase of 0.18 sq. in. in the area of the left ventricles on the twenty-four hour films over those taken on the day of the encephalogram. Again the results of the comparison of the ventricles of the twenty-four hour films were found to be due to chance and the values not significant.

DISCUSSION

It appears that second-day pneumoencephalography shows no statistical significance in the enlargment of the ventricles over the findings of the day of the encephalogram when calculated by both the linear and the square measurement.

No attempt was made in this series to determine whether the ventricles represent the normal size on the day of the encephalogram or on the twenty-four hour films, nor the cause of the change in size of the ventricles as was definitely seen on many of the roentgenograms.

Following the completion of the data on linear measurement, many errors were found to occur. The greatest error was in determining the points used to make the measurements and the angle at which to make these measurements. It was because of the inaccuracy of this method that the planimeter was used, hoping to obtain more accurate results.

There is also a great human error present in collecting the data from these roentgenograms, fatigue playing the greatest role. Are these errors important in the analysis of previously reported series, thus causing the wide variety of results? This factor did probably play a part; however, this question cannot be answered since no mention was made in previous articles as to the significance of the results obtained.

Second-day pneumoencephalography, in several cases of trauma, was of value in estimating the amount of cerebral damage by allowing the fluid to drain from the cerebral surface for a twenty-four hour period. No cysts were found in this series and no tumors were found, probably because this series contained such a large group of routine roentgenograms done on essentially normal brains.

The procedure followed is simple and easily carried out. The medication used seemed adequate to handle the severe headaches that occur with this operation; however, this fact cannot be definitely evaluated as all of these patients were psychotic and their response to pain may be different from that of the nonpsychotic patient.

Measurements of the lateral view of the ventricles was carried out but because of the difficulty in determining the same point of measurement on all of the films, these statistics were discarded. The planimeter was not used on the lateral views.

SUMMARY

Second-day pneumoencephalography was done on seventy-three cases. Fifty-one of these encephalograms were done on patients that gave no history of trauma or organic disease.

The technique used and the material available has been described and the final results analyzed. The results showed an increase in the size of the ventricles on the second day both by the linear and by the square measurement, but this increase in size was not of significance.

Though the increase in size of the ventricles is not significant, second-day pneumoencephalography should not be discarded as it has been shown to accentuate existing lesions of the brain that were questionable when the first roentgenograms were taken.

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SLIDING HIATUS HERNIA*

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A SIZEABLE literature has accumulated on the subject of diaphragmatic hernia since its demonstration was made possible by roentgenographic examination. Harrington[3–9] has written a number of excellent articles on the diagnosis and treatment of this condition, and his proposed classification of these lesions has found general acceptance.

It is the purpose of this paper to discuss only the roentgenologic features and diagnosis of the hiatus variety of diaphragmatic hernia, and specifically the so-called sliding or short esophageal type.

That esophageal hiatus hernia is a frequent finding during gastrointestinal examinations is attested to by the statement of Kirklin and Hodgson[10] who found that diaphragmatic hernias occur in between 1 and 2 per cent of all gastrointestinal examinations and that esophageal hiatus hernia represented more than 98 per cent of these cases. Hiatus herniations, excluding the rare congenitally short esophagus, are, in the vast majority of cases, of two anatomic types: the paraesophageal or more precisely parahiatus, and the sliding or short esophageal type. The latter variety is by far the more common, occurring in approximately 92 per cent of the group examined roentgenologically at the Mayo Clinic in 1944 and accounting for approximately 85 per cent of the group of hiatus hernias reported by Allison.[1] This corresponds closely to our experience. During the year 1950, 6,124 upper gastrointestinal examinations were performed in the Department of Radiology of this hospital. Diaphragmatic hernias of all types were found in 213 cases, an incidence of 3.47 per cent; of this group esophageal hiatus hernia accounted for 190 cases, or 89.6 per cent, and the sliding type of hernia represented 92.6 per cent of the group of hiatus hernias. Esophagitis, ulceration, and stenosis were present in 14.7 per cent of the sliding hernias.

The fundamental and important distinguishing feature between the paraesophageal and sliding varieties of hiatus hernia is the location of the esophageal cardiac junction. In the paraesophageal type, the esophagocardiac junction remains fixed below the diaphragm and the closing mechanism at the gastric cardia remains competent, whereas in the sliding type of hiatus hernia, the esophagocardiac junction is above the diaphragm forming part of the hernia. The closing mechanism at the gastric cardia in this latter variety is incompetent and allows reflux of gastric acid juices into the lower esophagus. Figure 1, taken from Sweet's textbook of "Thoracic Surgery"[13] is a schematic diagram of the anatomic relations of the two types of hiatus hernia. These two types of hernia, as Allison has emphasized, have a different symptom complex. The sliding hernia pushing the esophagocardiac junction above the diaphragm compromises the integrity of the closing mechanism at the gastric cardia, thus allowing the reflux of acid gastric juices into the lower esophageal segment. This results, if not corrected, in esophagitis, ulceration, and finally cicatricial stenosis and shortening of the distal esophagus with fixation of the herniated stomach. Surgical correction in this late stage then becomes a formidable procedure. It is important, therefore, that sliding esophageal hiatus hernia be recognized early so that corrective surgery will result in restoring the competence of the closing mechanism of the gastric cardia. The recognition of sizeable protrusions of the stomach above the diaphragm presents little difficulty to the roentgenologist (Fig. 2). In order, however, to understand the difficulties of the roentgenologist in interpreting

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small supradiaphragmatic pouches that may be found during examination of the upper gastrointestinal tract, it is necessary

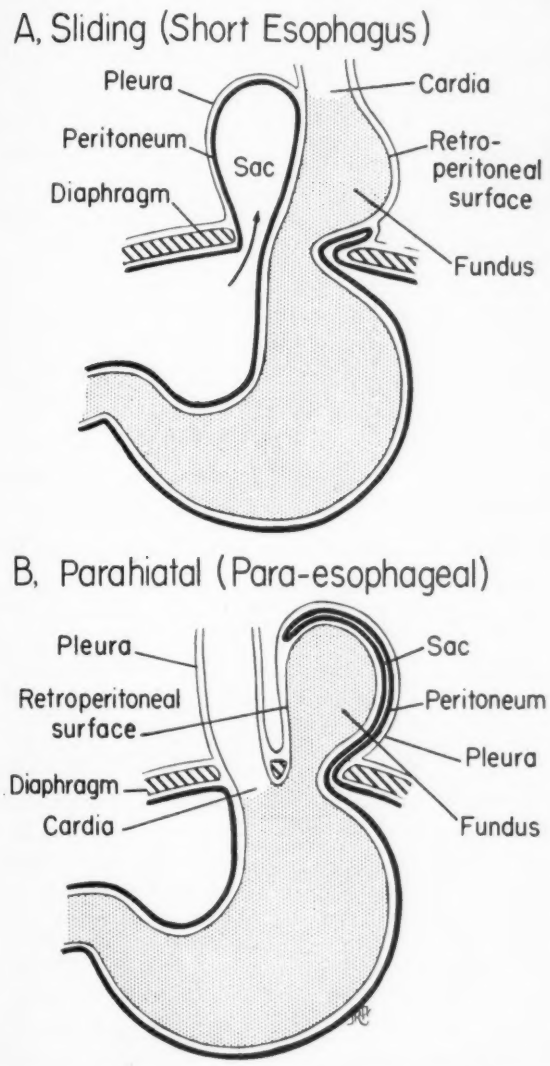

Fig. 1. Schematic diagram taken from Sweet's text on "Thoracic Surgery"[13] illustrating the anatomic relations of the two principal variations of esophageal hiatus hernia. Type A. Sliding type in which the gastric cardia is above the diaphragm, having been pushed up through the hiatus. In this type, the cardiac sphincter is incompetent, allowing reflux of gastric juice into the lower esophagus. Note that the hernial sac lies in front of the stomach. Type B, the less common paraesophageal hernia, has the gastro-esophageal junction maintained below the diaphragm preserving the integrity of the cardiac sphincter and preventing the reflux of gastric juices into the esophagus. (Reproduced by permission of the W. B. Saunders Co., Philadelphia, Pa.)

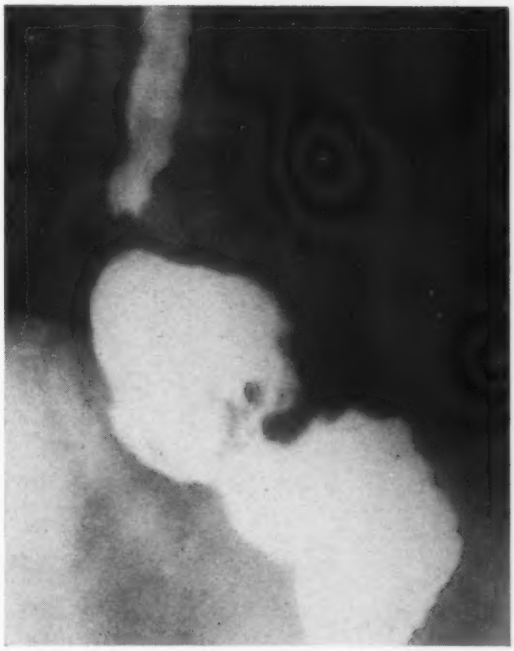

Fig. 2. Sliding hiatus hernia. The large size of the herniated segment of the stomach with the esophagus appearing to arise from the apex of the gastric pouch provides no difficulty in recognition.

to appreciate some of the confusion that exists regarding the anatomy and physiology of the lower esophagus. That a closing mechanism between the esophagus and the stomach exists is agreed upon by all investigators, but the nature of this mechanism has been the subject of considerable disagreement.

Much of the following historical background regarding the anatomical investigations of the lower esophagus has been taken from Templeton[14] and Lerche.[11] According to Templeton, Arnold in 1838 described a localized dilatation of the lower esophagus between two furrows placed 3 cm. apart. He called this local dilatation the "Vormagen" (anterior stomach). Luschka in 1857 described two dilatations of the distal esophagus. The lower one he termed the "cardiac antrum," and the upper one he placed above the diaphragm and called the "Vormagen," stating that the Vormagen described by Arnold was not the true Vormagen but the "cardiac antrum" (Fig. 3 and 4). The subject was still further con-

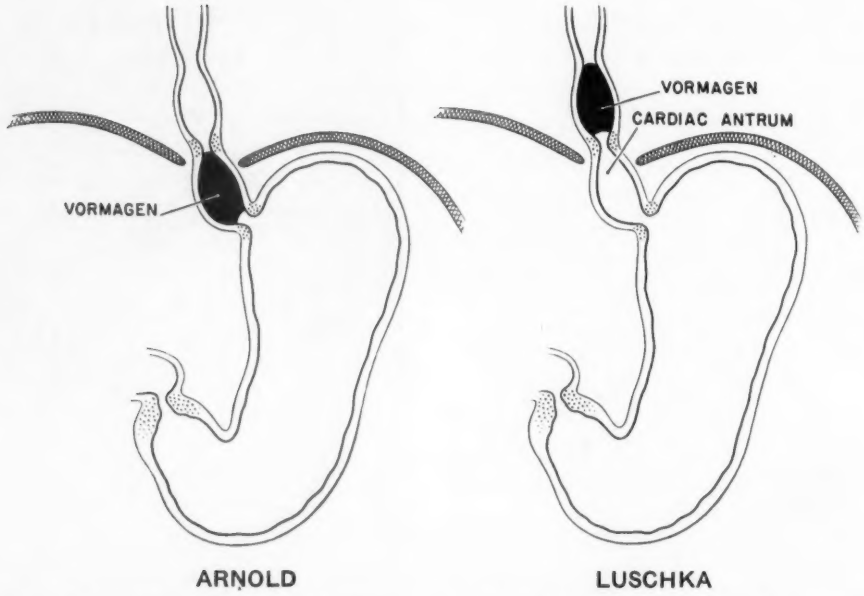

FIG. 3. Diagram of Arnold's and Luschka's "Vormagen." The "Vormagen" of Luschka corresponds to the phrenic ampulla later described by Hasse and Strecker. The infradiaphragmatic dilatation, which Luschka called the cardiac antrum, corresponds to the gastro-esophageal vestibule of Lerche.

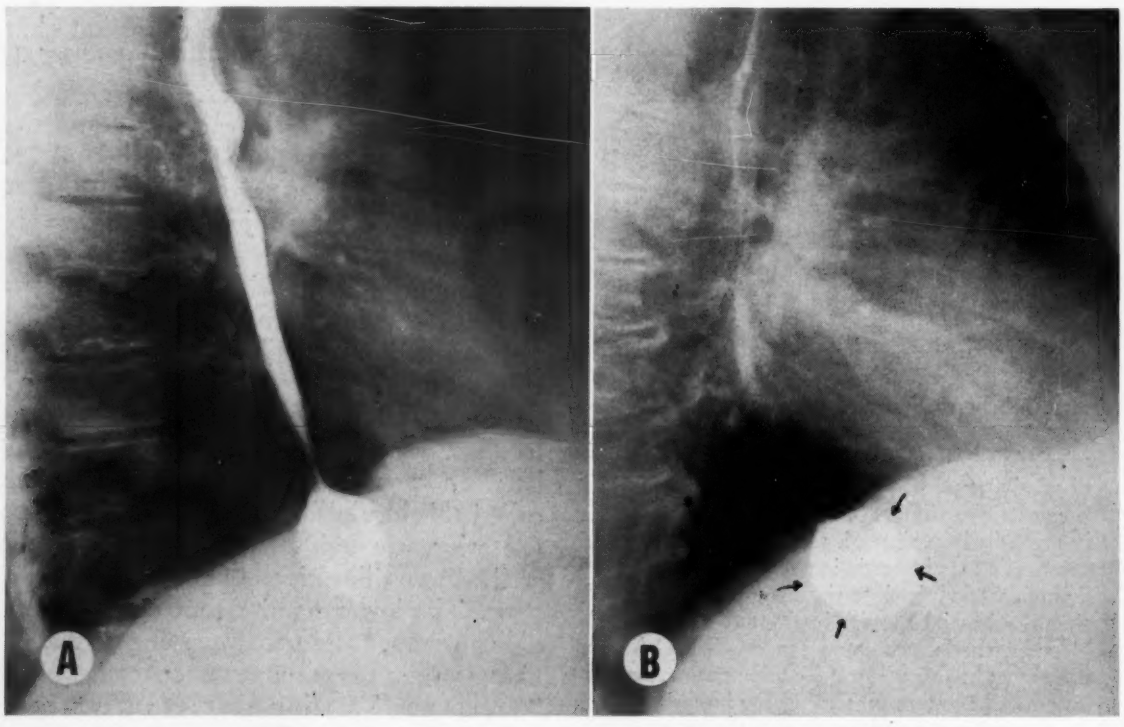

FIG. 4. (*A*) (*B*) Roentgenograms illustrating distended infradiaphragmatic segment of esophagus which corresponds to Luschka's cardiac antrum as shown in Figure 3. This is the segment that Lerche calls the gastro-esophageal vestibule.

fused by Schreiber who called the last 3–4 cm. of the esophagus above the diaphragm the "epicardia." According to Lerche, the localized dilatation of the lower end of the esophagus just above the diaphragmatic hiatus was described by Hasse and Strecker (1905), who called it the phrenic ampulla. Anders and Bahrmann[2] have designated the small pouch-like dilatations at the esophageal hiatus the "epiphrenic bell."

It had been known for many years that there was a localized thickening of the musculature of the esophagus just above the diaphragmatic hiatus. This has been generally known as the physiological constriction. Lerche states that his anatomical studies have demonstrated a sphincter mechanism in the lower esophagus located usually 1–2 cm. above the diaphragm and that it is the contraction of this sphincter which causes the phrenic ampulla. This is contrary to the more generally accepted explanation that the pinchcock action of the diaphragm on the esophagus during deep inspiration causes the phrenic ampulla. The fact that during roentgenoscopic examina-

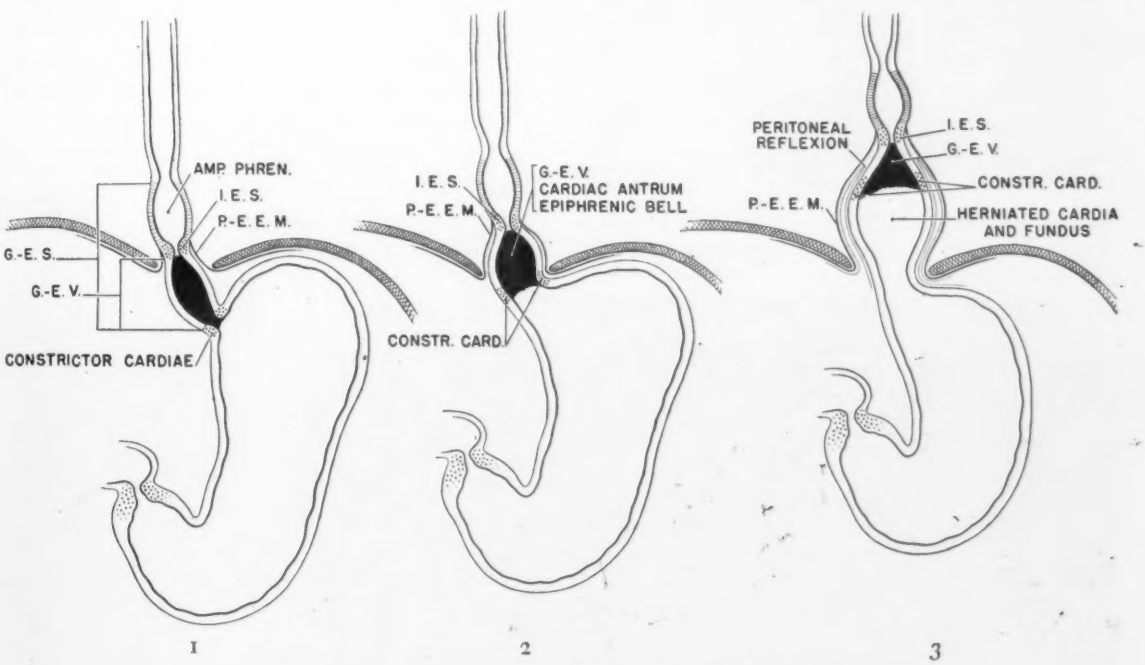

Fig. 5. Diagrammatic representation of lower esophageal segment and esophageal hiatus.

G.-E.V. = Gastro-esophageal vestibule (Lerche)
Cardiac antrum (Luschka)
Epiphrenic bell (Anders and Bahrmann)
G.-E.S. = Gastro-esophageal segment of expulsion
I.E.S. = Inferior esophageal sphincter (Lerche)
Constr. Card. = Constrictor cardiae
P.-E.E.M. = Phreno-esophageal elastic membrane (Laimer)
Amp. Phren. = Phrenic ampulla (Hasse and Strecker)

1. Relationships of the normal hiatus. Blacked in segment of esophagus = gastro-esophageal vestibule; cardiac antrum.

2. Relationships of hiatus in so-called hiatal insufficiency. The blacked in segment of esophagus lying partially in and partially above the hiatus, represents the distended gastro-esophageal vestibule, cardiac antrum or so-called epiphrenic bell of Anders and Bahrmann. It is this arrangement that is the most difficult of interpretation during roentgen examination, and must be differentiated from a small sliding hernia. This is frequently possible only by demonstrating, during the roentgenoscopic phase of the examination, the integrity or incompetence of the cardiac sphincter.

3. Diagram of sliding hiatus hernia in frontal plane showing the relation of the various structures.

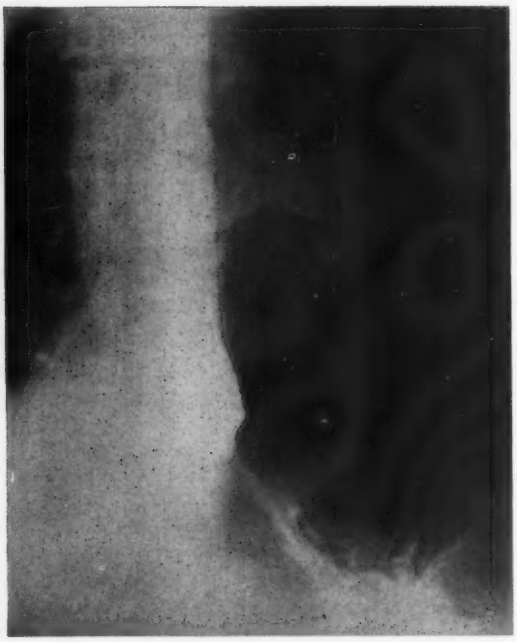

Fig. 6. Phrenic ampulla observed during ingestion of barium meal, and without inspiratory effort. Note sharp termination of barium column just above diaphragm with slight expansion above this point. A thin column of barium is seen in the infradiaphragmatic gastro-esophageal vestibule.

tion the barium column in the esophagus is frequently arrested at a point just above the diaphragm favors Lerche's opinion that there is an inferior esophageal sphincter. There is no question, however, that the arrest of the barium column and the subsequent dilatation above the point of arrest (phrenic ampulla) is accentuated by a deep inspiratory excursion. It is Lerche's opinion that the esophagus, as such, terminates just above the hiatus of the diaphragm. It is interesting to note in this regard that esophageal peristalsis stops at this same point, not extending to the cardiac orifice. The distal segment of the esophagus, including the ampulla and the "constrictor cardiae," Lerche refers to as the "gastro-esophageal

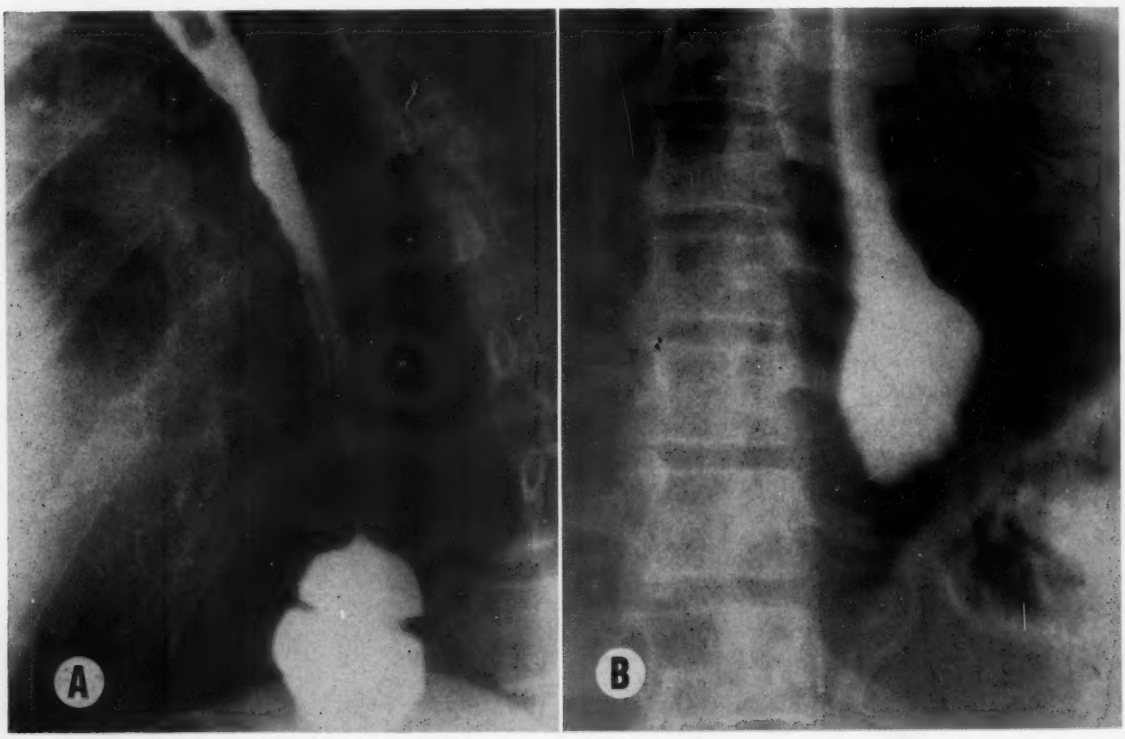

Fig. 7. (*A*) Accentuation of phrenic ampulla by deep inspiratory excursion. Note also the small notches on either side of the ampulla. These are constant in position. The cause of the notching is not known. They may represent the attachments of the phreno-esophageal elastic membrane. (*B*) Another illustration of phrenic ampulla. The smooth margins and conical apex are characteristic of this localized dilatation of the distal esophagus.

segment of expulsion" while that portion between the inferior esophageal sphincter and the "constrictor cardiae" he has termed the "gastro-esophageal vestibule" (Fig. 5). He further feels that he has convincingly demonstrated an anatomical constrictor at the cardia. The inferior esophageal sphincter he considers to be the center of a complex mechanism by which the distal gastro-esophageal segment expels its contents.

In the face of the anatomical confusion that has existed, one can appreciate the uncertainty of the radiologist concerning these small supradiaphragmatic protrusions. The difficulty arises in differentiating the small clinically important sliding hiatus hernia from the clinically unimportant dilatations of the lower esophagus. The phrenic ampulla offers little difficulty in recognition. It is a smooth dilatation of the lower esophagus with a conical apex approximately 2–4 cm. above the diaphragm frequently showing two small lateral notches (Fig. 6 and 7). The nature of the lateral notches is not known. They can be seen during the roentgenoscopic examination and they do not move or change in position. It is possible that these lateral indentations which are constant in position may represent the attachments of the phrenoesophageal elastic membrane, although Lerche states that this membrane inserts in the inferior esophageal sphincter which is at a slightly lower level. The so-called "epiphrenic bell" (cardiac antrum) of Anders and Bahrmann, which corresponds to the gastro-esophageal vestibule of Lerche may appear as a small dilatation above the diaphragm. Lerche, in some of his specimens, found the gastro-esophageal vestibule in the contracted state. The contracted "constrictor cardiae" in these cases was found partly in the hiatus and partly above it. Anatomically, this seems to account for many of the small hiatus protrusions that are seen in roentgenograms of the stomach during barium meal examinations and have been

Fig. 8. Roentgenogram illustrating a small supradiaphragmatic pouch. This represents a distended gastro-esophageal vestibule or cardiac antrum protruding through the hiatus tunnel. Anders and Bahrmann refer to this supradiaphragmatic esophageal dilatation as an "epiphrenic bell." This simulates a small hiatus hernia and cannot be differentiated from a hernia on the basis of roentgen appearance alone. The differentiating feature was the demonstration during the roentgenoscopic examination of the competence of the cardiac sphincter.

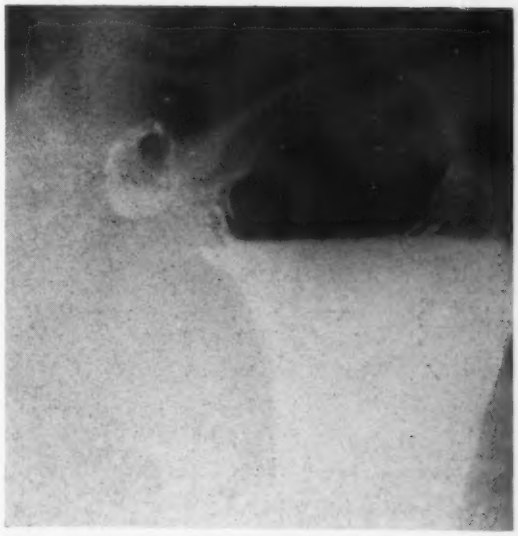

Fig. 9. Another illustration of a small hiatus protrusion simulating a small hiatus hernia. The mucosal pattern cannot be used as a reliable diagnostic aid.

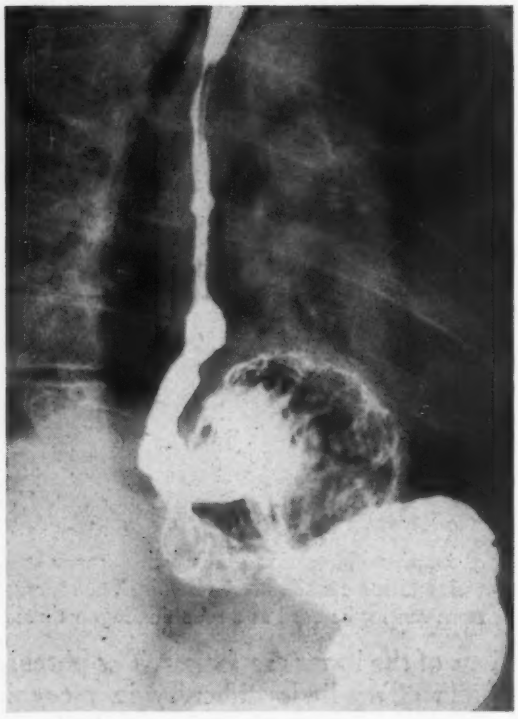

Fig. 10. Paraesophageal hernia. The esophagus is seen lying alongside the herniated fundus of the stomach with the gastro-esophageal junction in normal position below the diaphragm.

attributed to hiatus insufficiency (Fig. 8 and 9). By this term is meant abnormal laxity of the esophageal hiatus. This may be congenital or acquired. Harrington[9] has shown that in a significant proportion of individuals the esophageal hiatus may be quite patulous. In the course of 1,000 abdominal operations, he digitally palpated the hiatus and found that in 10 per cent of the cases he could insert two or more fingers. Acquired laxity of the hiatus occurs in old age. Schatzki[12] showed by roentgen studies that 50 per cent of a series of 30 elderly unselected cases had hiatus hernias, and this could be increased to 73 per cent when the intra-abdominal pressure was increased. It is thought to be the result of deterioration of the phreno-esophageal elastic membrane and atrophy of the subdiaphragmatic hiatus fat pad. Laimer (1883) was the first to describe the phreno-esophageal membrane and stated that it is the fixation apparatus of the esophagus. This membrane arises from the subdiaphragmatic fascia and unites with the fascia propria of the esophagus to clothe the lower esophagus in tent-like fashion. According to Lerche, the membrane functions as a stabilizer to the physiological excursions of the lower esophageal segment.

A small hiatus hernia has the same roentgenographic appearance as the clinically unimportant supradiaphragmatic protrusion caused by a distended gastro-esophageal vestibule (cardiac antrum) and thus cannot be differentiated on the basis of roentgen anatomy alone, unless it happens to be of the paraesophageal variety and the esophagus can be demonstrated lying along the side of the herniated pouch (Fig. 10). It has been shown by Allison[1] that the gastro-esophageal vestibule or cardiac antrum may be lined by gastric mucosa. Moreover, Lerche has demonstrated that the mucosal folds of the gastro-esophageal vestibule run transversely when the latter is in the contracted phase and thus on a roentgenogram may simulate gastric mucosa. Furthermore, it is known that the gastric mucosa is quite

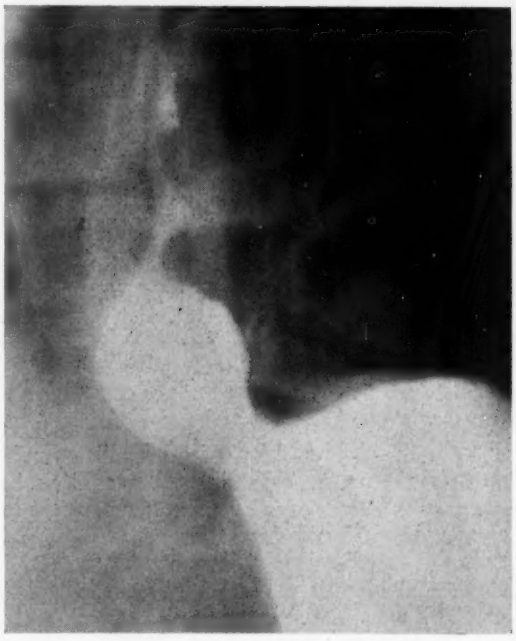

Fig. 11. Patient in Trendelenburg position with manual pressure applied to abdomen. A large supradiaphragmatic gastric pouch has been produced with reflux of barium up into esophagus.

mobile and may protrude into and through the hiatus during the act of belching. The mucosal appearance, therefore, cannot be used as reliable diagnostic aid. The important differentiating feature is not an anatomical factor but a physiological one; namely, the competence of the cardiac sphincter.

The adequacy of the closing mechanism of the stomach can be tested during the roentgenoscopic phase of the examination by increasing the intra-abdominal pressure. This may be done by placing the patient in the Trendelenburg position and applying manual pressure to the abdomen (Fig. 11). The prone with Trendelenburg position and the Valsalva maneuver may also be used. In this latter position, the angle at the esophagogastric junction is less acute than in the supine position and the hernia may be more easily demonstrated. A recently described means of increasing the intra-abdominal pressure is to have the patient stand sideways to the roentgenoscopic screen after the stomach has been filled with barium and bend over and touch the toes. In the case of a hiatus hernia, as the intra-abdominal pressure increases, the hernia will distend with barium refluxing through the incompetent cardiac sphincter (Fig. 12). If the cardiac sphincter is competent and prevents the regurgitation of barium, then the small supradiaphragmatic pouch is of no clinical significance.

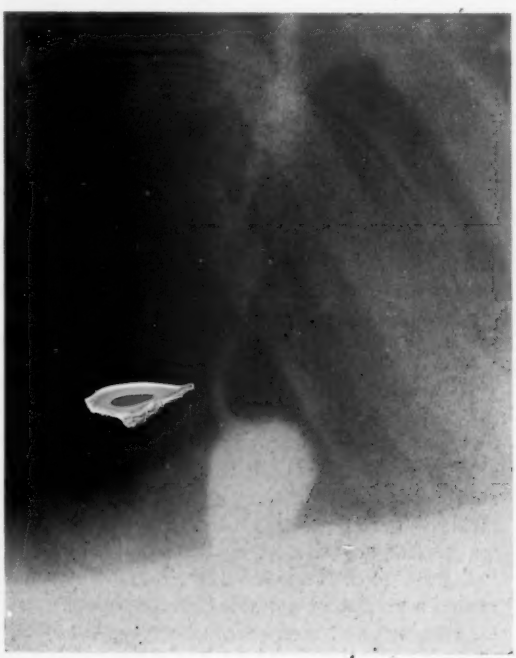

Fig. 12. Spot roentgenogram of patient standing sideways to roentgenoscopic screen, and bent over to touch toes. Note protrusion of small barium-filled gastric pouch above the diaphragm.

Fig. 13. A sixty-one year old malnourished female admitted to the hospital because of a fourteen month history of dysphagia, inability to eat solid foods, and burning substernal distress. Roentgenogram reveals stenosis of the distal esophagus as a result of chronic esophagitis with fixation of the herniated portion of the stomach. This patient had resection of the lower third of the esophagus, and specimen revealed the lumen to be so constricted that it would admit only the tip of a fine probe. On section there was a large area of mucosal ulceration with marked submucosal fibrosis, and no evidence of tumor.

The responsibility for early diagnoses must be shared equally between the clinician and the radiologist. The clinician, in that he is the first to see the patient and

Fig. 14. Roentgenogram demonstrating sliding hiatus hernia with chronic ulceration, fibrosis and stenosis of distal esophagus. The patient was a forty-three year old male with a three year history of dysphagia.

Fig. 15. Another illustration of sliding hernia with reflux esophagitis, ulceration and fibrosis. A forty-nine year old male with two year history of substernal burning pain coming on several hours after meals. A gastrointestinal series in April, 1948, was reported as negative for evidence of disease. A second gastrointestinal series in August, 1949, revealed a persistent annular constriction of the distal esophagus strongly suggestive of neoplasm. A gastrointestinal series done in this hospital in November, 1950, revealed a hiatus hernia of the sliding variety with esophagitis and ulceration. Esophagoscopy with biopsy demonstrated acute esophagitis.

evaluate his symptoms; the radiologist, in that with modern techniques he is responsible for demonstrating small herniations. The importance of early diagnoses and surgical correction of sliding hiatus hernia lies in the distressing symptoms, debilitation and physical incapacitation that it eventually produces. A vicious cycle of esophagitis, ulceration, cicatrization, stenosis, shortening and fixation of the hernia ultimately occurs (Figs. 13, 14 and 15). In the

Fig. 16. Roentgenogram illustrating how closely the roentgen appearance of chronic stenosing esophagitis mimics that of an annular carcinoma.

advanced stage, the deformity and stenosis of the distal esophagus may closely simulate cancer (Fig. 16).

SUMMARY

The opinions of the older anatomists regarding the distal esophageal segment have been reviewed together with the recent anatomical observations of Lerche. An attempt has been made to correlate the roentgen anatomy and physiology of the lower esophageal segment with these anatomical observations.

The difficulties in the differential roentgenographic diagnosis between the clinically important small sliding hiatus hernia and the clinically unimportant small supradiaphragmatic dilatations have been stressed. It has been shown that the distinguishing differential feature is frequently not made on roentgen anatomy alone but rather on the recognition of a physiological defect; namely, the demonstration of incompetence of the gastric cardiac sphincter with reflux of barium into the distal esophagus.

The importance of early diagnosis has been emphasized in order to permit surgical correction of the physiologically defective closing mechanism at the gastric cardia and so to prevent the development of chronic esophagitis, ulceration and stenosis, at which stage surgical correction might not be possible. The condition then becomes a most formidable surgical problem.

Attention has been drawn to the similarity in the roentgen appearance of the late stage of reflux esophagitis and stenosing carcinoma.

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ROENTGENOGRAPHIC DEMONSTRATION OF ALTERATIONS OF THE DUODENAL LOOP BY EXTRINSIC LESIONS*

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EXAMINATION of the barium filled duodenum is often useful in localization and study of adjacent organs or masses of the pancreas, liver, gallbladder, the right kidney, omental cysts, and retroperitoneal masses. The duodenal loop is often the center of much roentgenological speculation with reference to the presence of pathology of the head of the pancreas. The size of the duodenal loop varies with the body build. In the asthenic subject, the pylorus is situated lower and closer to the spine than in the athletic and asthenic subjects.

It is our purpose to present cases in which the duodenum has been displaced and distorted by paraduodenal disease. The duodenum normally has the following anatomical relations: The first or bulbous portion is intimately related to the gallbladder and the posterior mesial surface is in contact with the common bile duct, the gastroduodenal artery, the portal vein and the interior vena cava. The second or descending portion is related posteriorly to the right kidney, renal vessels, and the inferior vena cava. Anteriorly it may be crossed by the transverse colon and medially it is in contact with the head of the pancreas and the common bile duct. The third or transverse portion lies behind the peritoneum with the inferior vena cava, lumbar spine, and aorta. It is crossed by the jejunoiliac mesentery. The fourth portion ascends to the duodenojejunal flexure.

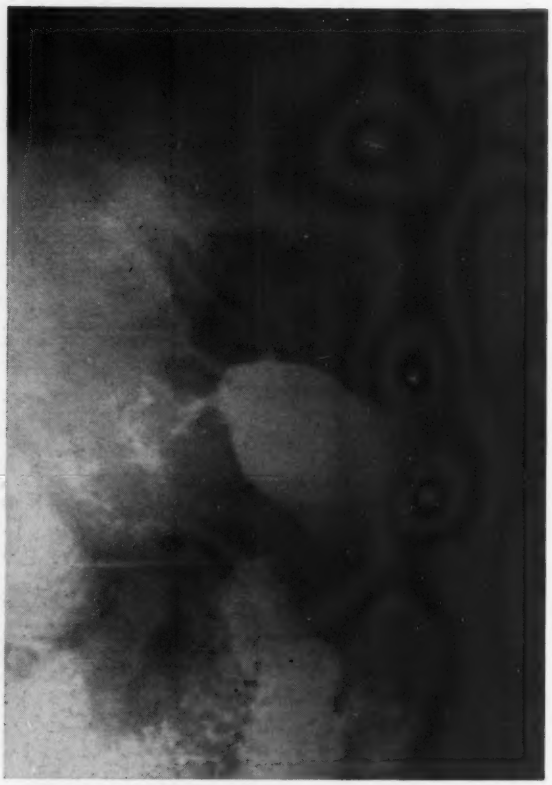

FIG. 1. Case I. A markedly redundant duodenum.

Redundancy of the superior duodenum, a congenital anomaly is illustrated in Figure 1 (Case 1). In this case the duodenum is longer than the usual 12 fingerbreadths (hence the name duodenum), and the extra loop is held in place by the hepatoduodenal and hepatocolic ligaments.

A less frequent anomaly is illustrated in Figure 2*A* and *B* (Case II). This is a case of inverted duodenum with nonrotation of the jejunum and the large intestine. The jejunal loops are situated on the right side of the abdomen and the colon on the left.

Case III, white male aged fifty-nine, complained of weight loss and weakness, with gradual increase in the size of the abdomen. Examination disclosed a large retroperitoneal mass. The barium meal and the barium enema (Fig. 3*A* and *B*) show the entire intestine to be pushed to the left. Lateral views showed forward dis-

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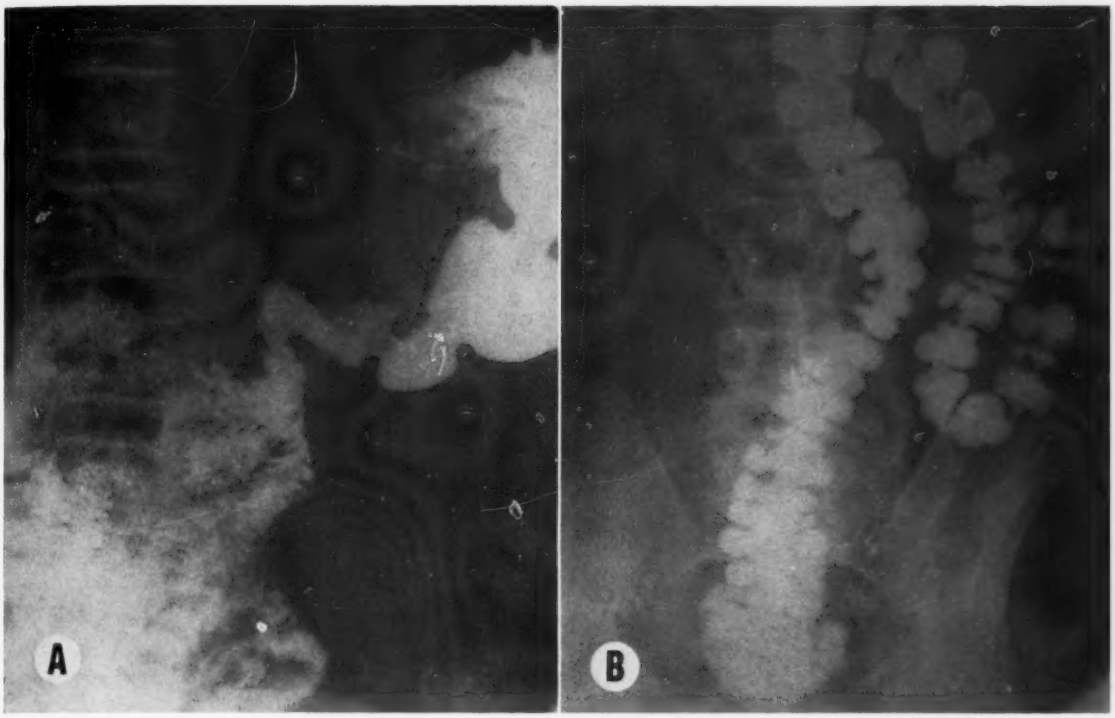

Fig. 2. Case II. (*A*) A case of congenital nonrotation of the intestine with inversion of the duodenum. (*B*) The colon in the same case of congenital nonrotation.

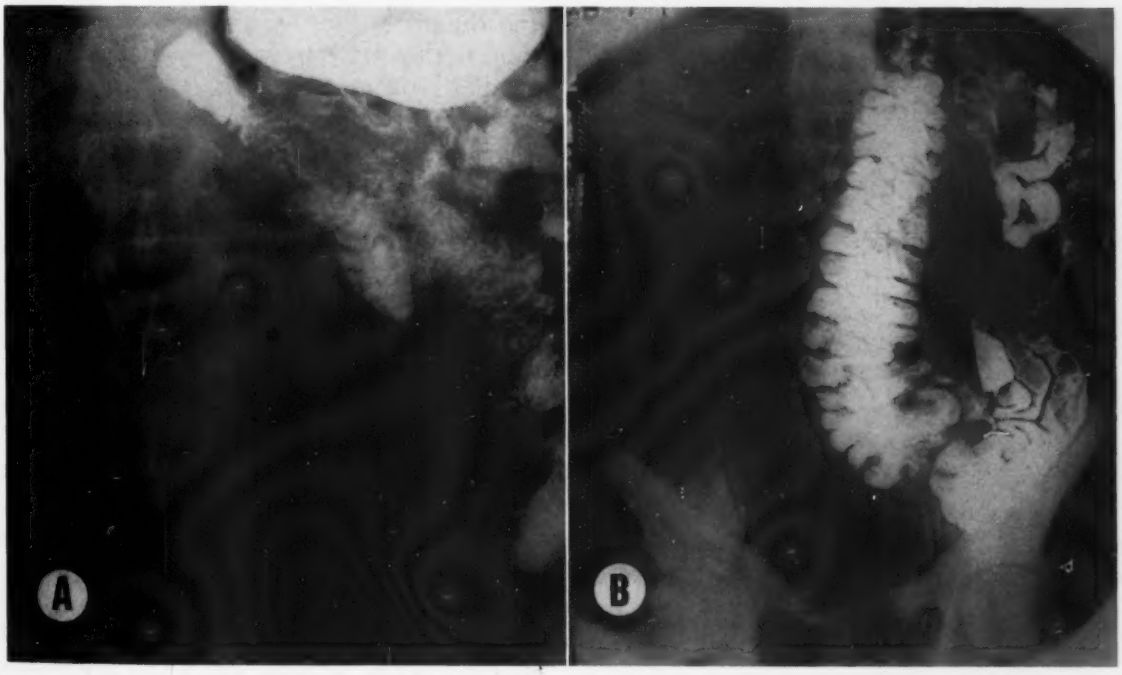

Fig. 3. Case III. (A) The stomach and duodenum are pushed to the left by a large retroperitoneal liposarcoma. (*B*) The colon and ileum are also pushed to the left.

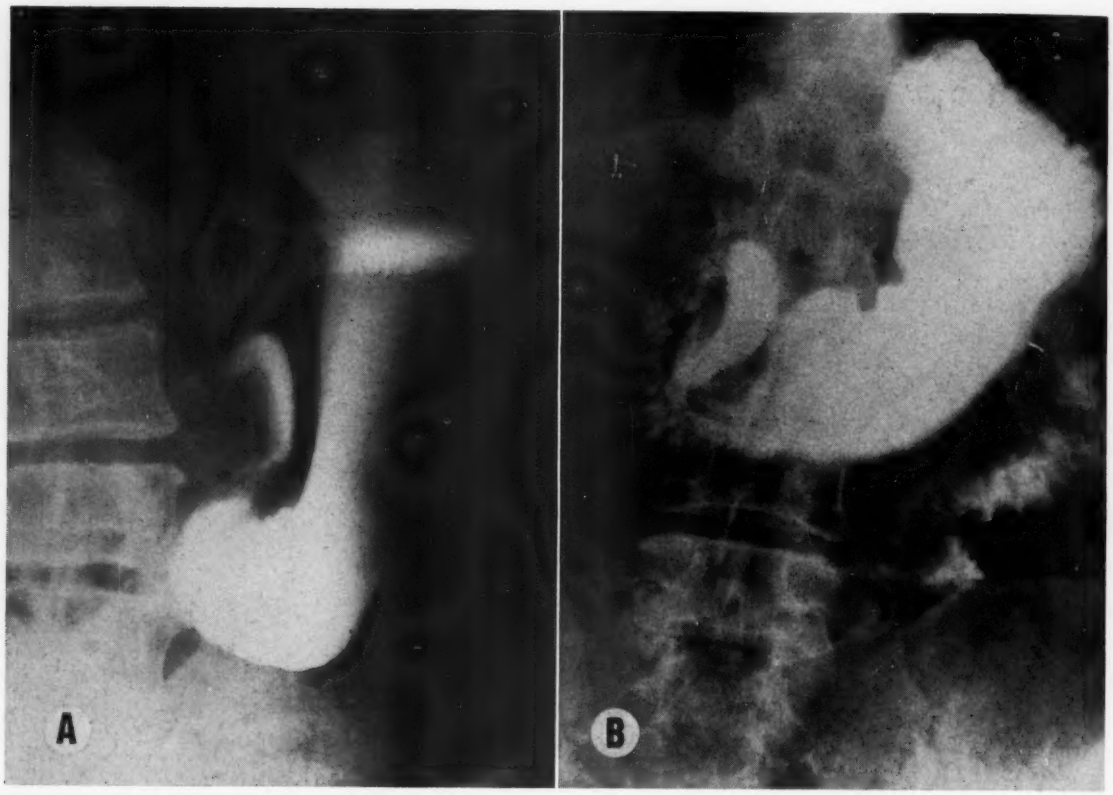

FIG. 4. Case IV. (*A*) Carcinoma of the gallbladder compressing the duodenal bulb. (*B*) Posteroanterior view.

placement of the intestines. The mass had a radiolucent center, and the roentgenological diagnosis was retroperitoneal lipoma. At laparotomy a retroperitoneal liposarcoma, measuring 15 by 28 cm., was removed. In this case the entire small and large intestines are seen pushed to the left in contradistinction to the case of nonrotation, in which the small intestine is on the right side.

When asymmetry of the duodenal bulb can be demonstrated, this may represent unusual enlargement of the left lobe of the liver or compression by an extrinsic mass either inflammatory or neoplastic. An example of extrinsic pressure on the bulbous portion of the duodenum was observed in a patient complaining of abdominal pain, weight loss, jaundice and weakness. An exploratory operation revealed carcinoma of the gallbladder with metastases to the liver. The compressed duodenal bulb is illustrated by the enlarged neoplastic gallbladder in Figure 4*A* and *B* (Case IV).

An example of marked displacement of the duodenal loop was observed in a patient with polycystic kidneys and is demonstrated by Figure 5*A* and *B* (Case V).

Widening of the duodenal loop, displacement of the duodenal loop, towards the right and anterior, diminution of the diameter of the duodenum, or alteration of duodenal peristalsis or of the mucosal pattern of the duodenum may signify expansion of the head of the pancreas. The smoother deformities are usually due to pancreatic cysts. In Case VI (Fig. 6), the walls of the pancreatic cyst are calcified. At operation a large pancreatic cyst was found.

When the duodenal loop is expanded and there are destructive changes of the duodenal mucosa or if there is irregularity of contour of the inner concave border of the descending portion with or without changes of the mucosal pattern, carcinoma of the head of the pancreas must be suspected. Case VII (Fig. 7) is an example of persistent irregularities of the inner con-

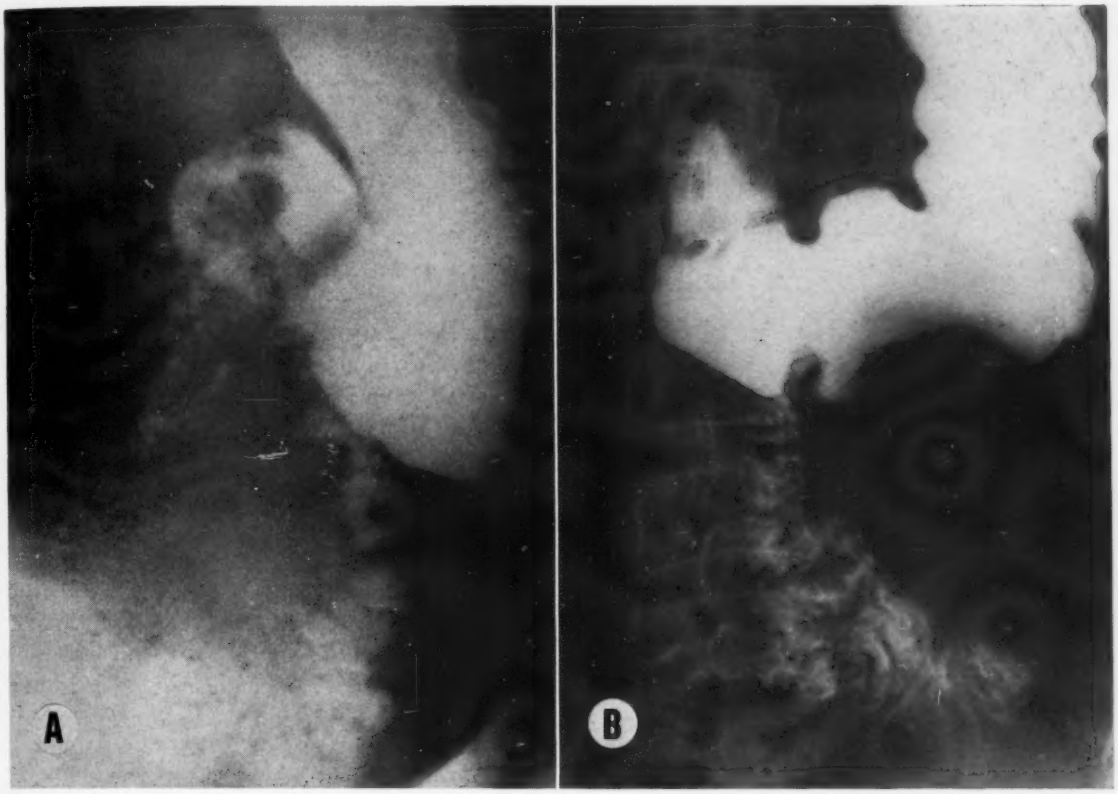

Fig. 5. Case v. (*A*) Distortion and compression of the duodenal loop by an enlarged right kidney. Intravenous and retrograde urographic studies showed polycystic right kidney. (*B*) Extrinsic pressure on the greater curvature of the stomach by the enlarged polycystic left kidney.

tour of the descending portion of the duodenum. This patient complained of loss of weight, jaundice, and tarry stools. He died suddenly and at autopsy an adenocarcinoma of the head of the pancreas obstructing the common bile duct and eroding the duodenum was found.

Case viii presented ample roentgenological evidence for the diagnosis of extensive carcinoma of the pancreas (Fig. 8). He was hospitalized because of jaundice and vomiting. A modified Whipple operation was done and laboratory examination of the specimen removed revealed chronic pancreatitis with stenosis of the common bile duct at the ampulla of Vater.

Fig. 6. Case vi. Demonstration of compression with displacement of the duodenal loop and the stomach by a large cyst of the pancreas. Note the smooth calcified wall.

FIG. 7. Case VII. Illustrates irregularity, deformity and ulceration of the supra-ampullary portion of the duodenum due to a carcinoma of the head of the pancreas.

Case IX, a diabetic with abdominal pain, diarrhea, and vomiting was noted to have gastric retention and displacement of the duodenum when examined with the barium meal. There were calcifications in the pancreas. Barium enema revealed fistulae from the hepatic and splenic flexures of the colon to the region of the pancreas. At operation the pancreas was enlarged and stony hard; dense bands adhered to the duodenum and the flexures of the colon to the pancreas. Pathological examination of the specimen revealed fibrosis and chronic inflammation of the pancreas. The outlines of the fistulae are demonstrated in Figure 9. Neither Case[1] nor Poppel and Marshak[2] mentioned finding fistulae associated with chronic

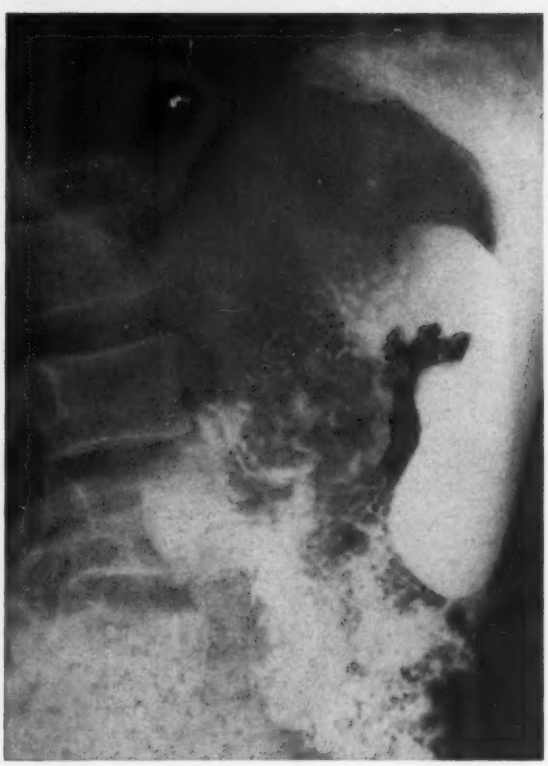

FIG. 8. Case VIII. A case of pancreatitis with marked disturbance of the mucosal folds of the second portion of the duodenum.

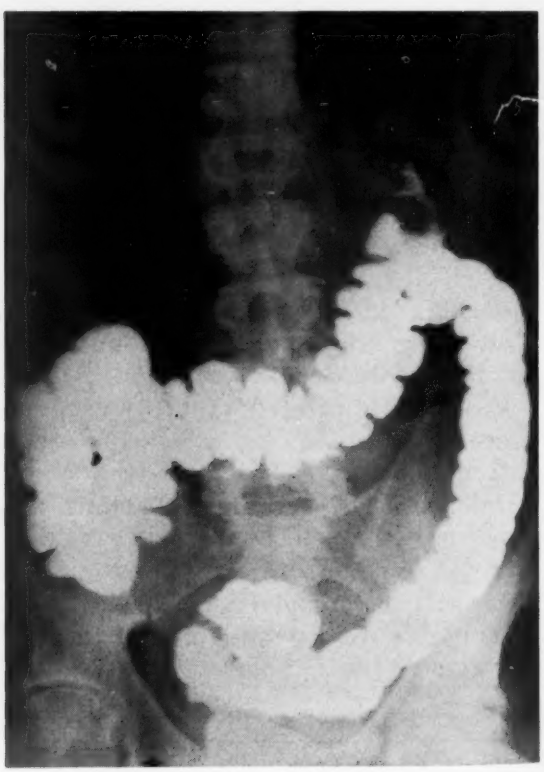

FIG. 9. Case IX. Repeat barium enema reveals a second fistula between the pancreas and the splenic flexure of the colon.

pancreatitis in their excellent papers on roentgen diagnosis of pancreatic disease.

If widening of the duodenal loop is associated with the presence of paralytic ileus, haziness of the abdomen, coarsening of the small intestinal mucosal pattern, elevation of the stomach, limitation of the diaphragm with formation of pleural exudate, the diagnosis of acute pancreatitis must be suspected.

Case x was admitted with a four day history of abdominal pain accompanied by nausea and vomiting. On admission the abdomen was tender, rigid, and slightly distended. He had a white blood cell count of 35,000 and a serum amylase titer of 560 units. The patient was given small doses of roentgen radiation to the pancreas. On the first day he received approximately 25 r tissue dose, 200 kv., 15 ma., 50 cm. skin target distance with filtration of 1 mm. Cu. The following day a second similar dose was given to the pancreas. He was markedly improved for a few days, then an exacerbation of the original symptoms occurred. The gallbladder did not visualize with the Graham-Cole test. A small barium meal was given. The duodenal loop was markedly widened and the intestine was distended by gas and fluid (Fig. 10). At exploratory laparotomy, the gallbladder and common bile duct were filled with soft cholesterol stones. The pancreas was enlarged and a large pseudocyst containing a liter of bloody fluid was found in the tail of the pancreas.

Fig. 10. Case x. A case of acute pancreatitis demonstrating marked widening of the duodenal loop with distention of the intestine by gas and fluid.

SUMMARY

The roentgenographic diagnosis of pancreatic disease depends to a large extent on the appearance and position of the barium filled duodenal loop. Furthermore, the duodenum may be distorted by an enlarged lesser lobe of the liver, a distended or neoplastic gallbladder or common bile duct, omental cyst, aneurysms from the upper abdominal aorta, and polycystic kidneys. Diaphragmatic herniation of the stomach may also distort the duodenum with resulting deformity.

Cases of displacement and distortion of the duodenal loop by extrinsic and intrinsic disease are presented, consisting of instances of the following: redundancy and inversion of the duodenum, retroperitoneal liposarcoma, carcinoma of the gallbladder, polycystic right kidney, cysts of the pancreas, carcinoma of the head of the pancreas, acute and chronic pancreatitis.

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COMPARATIVE STUDY OF VARIOUS RADIATION METHODS AS ADJUNCTS TO SURGERY IN CARCINOMA OF THE CORPUS UTERI*

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DURING the past decade the literature on the treatment of carcinoma of the corpus uteri has been enriched by many notable publications. Various methods of irradiation have been analyzed and their scope in relation to surgical procedures critically evaluated. Definite facts have been established and fundamental rules laid down as to the most desirable therapeutic approach when the cancer is in an operable or inoperable stage.

It would therefore seem that nothing new could be added to the subject. Yet, the more recent trend toward extremely radical operative interventions in all types of cancer might justify the presentation of long-range statistical studies in larger groups of cases treated along more conservative lines. In carcinoma of the corpus uteri such studies might help to offer further documentary evidence for reassertion of time-tested principles which must remain the basis of future treatment. The present paper is given with that view in mind.

MATERIAL

The series studied includes 240 patients who were treated at Harper Hospital from 1924 to 1945 inclusive by means of intracavitary radium, external roentgen therapy and hysterectomy in various combinations. In compiling statistically the end-results and analyzing the various factors related to these results, only the patients known to be, or to have been, alive at the particular period studied are considered as survivors for that period. The untraced cases which amounted to 2 per cent of the total during the first five years following treatment and increased up to 10 per cent in the succeeding five year survival periods were all assumed to have died from cancer. Furthermore, any death, regardless of the cause, was attributed to carcinoma, even if no such lesion could be demonstrated at the postmortem examination. In comparing various methods, no case was eliminated on the ground that a contemplated plan could not be brought to a satisfactory conclusion. Neither was any patient omitted because the cancer was too advanced to be treated or only palliative treatment could be given. Thus the survival rates in the series recorded here represent the lowest possible values.

HISTORICAL REVIEW OF THE PLANS OF TREATMENT USED

At the beginning of this century hysterectomy constituted the sole method of treatment in carcinoma of the corpus uteri. In 1915 radium therapy in various forms made its appearance and for nearly a decade it was employed on a trial and error basis, either as a solitary measure or in association with hysterectomy, applied before or after the operation. Then in the early 1920s deep roentgen therapy with 200 kv. was introduced and a tendency developed to replace radium with this latter, usually given postoperatively. Inasmuch as the uterus had already been removed it seemed more logical to attempt to destroy the possible residual cancer cells by roentgen rays which could be directed to a larger area than by the rather localized action of the radium which could be placed only against the thin vaginal vault. Furthermore, it was thought that the proximity of such radiosensitive organs as the

* Presented at the Thirty-third Annual Meeting, American Radium Society, Atlantic City, N. J., June 7–9, 1951.

bladder and rectum would add to the risk of injuring these structures if a sufficiently large dose was given to produce an effect on the more distant parametria.

At Harper Hospital radiation therapy, both with intracavitary radium and external deep roentgen therapy, was inaugurated for the treatment of carcinoma of the corpus uteri in 1924. Commensurate with the vogue of the time the doses in the beginning were rather small, so as not to produce too much reaction on the normal structures. The operable cases were treated, with very few exceptions, by an association of hysterectomy and two or three series of postoperative deep roentgen therapy. The inoperable cases were subjected to a combined radium and roentgen therapy.

Soon it become apparent that greater benefit could be derived from the irradiation if the destructive action of both agents could be used in a more efficient manner. Therefore, in 1928, Dr. Kamperman,[8,9] Chief of the Department of Obstetrics and Gynecology of Harper Hospital, conceived the plan that a full course of intracavitary radium and external deep roentgen therapy be given prior to hysterectomy, which was done six to eight weeks later, and that a second series of deep roentgen therapy be administered two or three weeks after the operation. He also recommended that the dose of both agents be raised, whenever necessary, to the upper limit of tolerance of the normal structures.[10,11]

In further pursuing this plan, another important step was undertaken in 1932 when a supervoltage roentgen therapy apparatus was installed, operating at 500 to 600 kv. constant potential. For a few years deep roentgen therapy and supervoltage roentgen therapy were used in an alternating manner, then since 1937 all cases have been treated by supervoltage roentgen therapy exclusively.

Based on the aforementioned historical developments, three periods are distinguished in making a comparative statistical survey of the cases presented in this series: *Period I* extended from 1924 to 1932 and included 53 cases treated by deep roentgen therapy in association with surgery in the operable cases and with intracavitary radium in the inoperable cases. During this period only 5 of the 31 patients operated upon had preoperative irradiation consisting of intracavitary radium and external deep roentgen therapy, whereas in 26 patients external roentgen therapy was given following hysterectomy. The ratio of the two methods was 1:5.2. *Period II* extended from 1933 to 1936 and was characterized by the fact that 35 patients were treated by deep roentgen therapy and supervoltage roentgen therapy in an equal proportion. The other methods remained the same except that preoperative irradiation was used more frequently in the 16 operable cases. The ratio of the patients subjected to preoperative irradiation to those treated by hysterectomy and postoperative roentgen therapy was 1:2.2. *Period III* started in 1937 with the exclusive use of supervoltage roentgen therapy. Up to 1945, 152 patients were treated. During this period the number of operable cases amounted to 88 and the ratio of the patients who received preoperative irradiation to those who were treated by hysterectomy and postoperative roentgen therapy rose to 1.6:1. The inoperable cases continued to be treated with intracavitary radium as an adjunct to supervoltage roentgen therapy.

The number of patients operated upon in the three periods constituted: I, 58 per cent, II, 46 per cent and III, 58 per cent.

TECHNIQUES

Although it is not the aim of the present paper to give a detailed account of all of the therapeutic plans employed, a brief description of the most common techniques may not be out of place.

(1) *Radium.* This agent was used in three forms: (a) For the intrauterine irradiation linear applicators were devised consisting of single or in tandem multiple tubes with 0.5 mm. Pt and 1 mm. hard rubber filtration. The length of the appli-

cator was determined individually so as to extend from the middle of the cervical canal to the top of the uterine cavity. The radium was distributed in amounts of 12.5 mg. per 1 cm. active length and the outer diameter of the tubes measured 1 or 1.5 cm., the latter dimension being preferred whenever possible. The most frequently used tube was 4 cm. in active length, containing 50 mg. of radium. The dose was rather small in the early days but since 1928 it has been raised to an average of 5,000 to 6,000 mg. hr. This is now considered to be the standard dose for the preoperative application in the operable cases in which the radium is combined with roentgen therapy. If a 50 mg. radium tube of 4 cm. active length and of 1.5 cm. diameter is applied for 96 hours, or a total of 4,800 mg. hr., the dose amounts to 33,120 gamma roentgens (in the center of the tube) at the contact with endometrium, 4,848 r_γ on the outer surface of the uterus if the wall is 2 cm. thick and to 1,536 r_γ in the distant parametria 5 cm. away from the axis of the tube. In this form of treatment no attempt is made to deliver a larger total dose to the site of the cancer by utilizing, for example, multiple tubes of small size according to the method of Heyman,[6,7] Arneson,[2] and others, since the uterus is removed subsequently. The aim of the irradiation is to produce an effect on the extrauterine extension of the carcinoma rather than to try to destroy completely the primary intrauterine focus.

In the inoperable cases two radium applications are made, at an interval of about eight to ten weeks, on each occasion combined with external roentgen therapy. The technique and the dose of the first application are the same as for the above described preoperative course. Here, too, straight applicators are used without resorting to the effort of locally destroying the carcinoma by means of multiple small sources. Experience shows that if part of the tumor was inadequately treated the first time, the second radium application, in view of the marked shrinkage of all structures, will help to eradicate the carcinoma locally by producing at the same time a beneficial effect on the extrauterine extension which now has been brought closer to the axis of the radium tube. The dose of the second radium aplication is 25 per cent less than that of the first.

(b) The second form of radium therapy was devised for irradiation of the cervical stump or vaginal vault following hysterectomy when there was evidence that the carcinoma had invaded these structures. Several successive techniques were tried, making use of radon bombs, concentrated radium tubes or flat applicators but they had to be discarded because of too much reaction on the neighboring stuctures, especially the rectum and bladder. Since 1933 a technique has been successfully employed consisting in the local application of low intensity radium tubes for a prolonged time. The two arms of a colpostat are tied together and packed with the axes transversally against the cervical stump or vaginal vault. Each arm is 2 cm. long and contains 10 mg. of radium, or 5 mg. per 1 cm. active length, filtered by 0.5 mm. Pt and 1 cm. soft rubber. The radium is left in situ for 168 hours, giving a total dose of 3,360 mg. hr., which corresponds to 13,238 r_γ at contact with the tissues and to 5,242 r_γ at the site of the removed internal os (2 cm. away from the the axis of the tubes). This radium application is supplemented by a full course of external roentgen therapy which is repeated (without radium) eight to ten weeks later.

(c) The third form of radium therapy was employed in the rare cases of implant metastases along the vaginal canal or around the orifice which usually occurred years after the treatment of the original lesion. It consisted of interstitial application of low intensity radium needles for a total dose of 5,000 r_γ in seven days and followed by an additional full series of supervoltage roentgen therapy.

(2) *Roentgen Therapy.* As already stated, two types of roentgen rays were used for the external irradiation. (a) The physical

factors of the deep roentgen therapy were: 200 kv. (peak), 1.5 mm. Cu, 1 mm. Al, half-value layer of 1.9 mm. Cu and an intensity of 10 r/min. at 50 cm. skin-target distance. In most instances the multiple field fractionated protracted method was employed extending over a period of three to four weeks. The total dose on the uterus amounted to approximately 3,000 to 4,000 r (in addition to the radium).

(b) The physical factors of the supervoltage roentgen therapy used routinely since 1933 were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al, 3 mm. celluloid, half-value layer of 9 mm. Cu and an intensity of 20 r/min. at 60 cm. skin-target distance. The dose was 2,500 r on the uterus, delivered through two, four or five portals (depending on the diameters of the pelvis) within eight to ten days.

In the operable cases one series was given in combination with intracavitary radium before hysterectomy and another without radium after hysterectomy. If at the operation an extension into the cervical canal was found, the second series of supervoltage roentgen therapy was supplemented by a second course of radium applied intravaginally according to the technique described in 1(b). If a hysterectomy had been performed without preliminary irradiation, three series of supervoltage roentgen therapy were given, usually at intervals of eight to ten weeks from each other.

In the inoperable cases two series of supervoltage roentgen therapy were employed in conjunction with the above described radium techniques.

(3) *Surgery*. The technique used for hysterectomy in this series varied considerably. In the majority of cases an abdominal panhysterectomy was done with bilateral salpingo-oophorectomy but without dissection of the parametria and regional pelvic lymph nodes.

METHODS

In general, the methods pursued fell into three categories: (A) preoperative irradiation, plus hysterectomy six to eight weeks later, plus postoperative irradiation two to three weeks after the operation; (B) hysterectomy, plus two or three series of postoperative irradiation, at intervals of eight to ten weeks from each other; and (C) irradiation alone.

Methods A and B were used in the operable cases, whereas method C was reserved for the inoperable cases. It must be stated, however, that a certain number of patients who at the original examination have been classed as inoperable have been rendered operable by the first series of irradiation and then treated according to method A.

STATISTICAL ANALYSIS

(1) *Over-all Results*. The rate of survival was analyzed for the five, ten, fifteen, and twenty year periods. A compilation of the results is shown in Table 1. As may be noted, there was a definite improvement over the years. While during Period I the five year survivors represented 45 per cent, in the patients of Period II this figure rose to 50 per cent and in the patients of Period III to 60 per cent. The ten, fifteen, and twenty year survival rates followed a similar pattern, except, of course, for the fact that there was a gradual and proportionate decrease in the percentage figures incidental to advancing age.

(2) *Relationship of Results to Age*. Table II gives the age distribution in the 240 cases. The average age was fifty-six years, the youngest patient being twenty-eight, and the oldest eighty-one years of age. The highest incidence was noted in the decade between fifty and fifty-nine years (36.3 per cent), closely followed by the decade between sixty and sixty-nine years (30.8 per cent). The combined total of these two decades amounted to 161 cases, or two-thirds of all patients treated.

The relationship of the age to the results obtained by the various methods of treatment is shown in Table III. As may be noted, in the operable cases the average age at the time of the treatment in those patients who lived five years or longer was

TABLE I

OVER-ALL SURVIVALS IN CARCINOMA OF CORPUS UTERI

Years	Cases	Well 5 Years		Well 10 Years		Well 15 Years		Well 20 Years	
		Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
1924	2	1	50	1	50	—	—	—	—
1925	3	1	33.3	1	33.3	—	—	—	—
1926	7	2	28.6	2	28.6	2	28.6	2	28.6
1927	6	2	33.3	1	16.6	1	16.6	1	16.6
1928	1	—	—	—	—	—	—	—	—
1929	7	2	28.6	2	28.6	2	28.6	1	14.2
1930	4	3	75	3	75	2	50	1	25
1931	11	6	54.5	5	54.5	3	27.2		
1932	12	7	58.3	5	41.6	5	41.6	5	16.6
Total	53	24	45	20	37.7	15	28.3		
1933	6	3	50	2	33.3	1	16.6		
1934	6	3	50	2	33.3	1	16.6		
1935	12	5	41.6	4	33.3	3	25.0		
1936	11	7	63.6	3	27.2				
						20	26.2		
Total	35	18	50	11	31.4				
1937	13	6	46.1	4	30.7				
1938	20	11	55	8	40.0				
1939	21	11	52.4	6	28.5				
1940	19	13	68.4	10	52.6				
1941	10	5	50.0						
1942	14	9	67.3	59	36.6				
1943	19	13	68.4						
1944	17	9	53						
1945	19	14	74.7						
Total	152	91	60						
GRAND TOTAL	240	133	55.4						

51.6 years when method A and 52.7 years when method B was used, and in the patients who lived less than five years 54 and 54.5 years respectively. In comparison, the average age of the patients who were considered inoperable and were therefore treated by irradiation alone amounted to 57.9 years in those who survived for five years or longer and to 61.9 years in those who died within less than five years. This fact is readily understandable since advanced age and the various geriatric diseases or complications usually constitute the most frequent causes of inoperability in most malignant neoplasms.

TABLE II

CARCINOMA OF CORPUS UTERI AGE DISTRIBUTION

Years	Number	Per Cent
20–29	1	0.4
30–39	14	5.8
40–49	43	17.9
50–59	87	36.3
60–69	74	30.8
70–79	20	8.3
80–89	1	0.4
TOTAL	240	100

A further study was made on the influence of age upon survival exceeding five years (Table IV). It was found that the

TABLE III

CARCINOMA OF CORPUS UTERI RELATION OF AGE TO METHOD OF TREATMENT

Method of Treatment	Lived 5 Years or Longer		Died in Less Than 5 Years	
	Cases	Average Age	Cases	Average Age
A. Preoperative irradiation; hysterectomy; postoperative irradiation	54	51.6	10	54.0
B. Hysterectomy; postoperative irradiation	34	52.7	37	54.5
C. Irradiation only	45	57.9	60	61.9
TOTAL	133	53.9	107	58.5

Average age of 240 cases: 56 years.

twenty year survivors had an average age of 45 years at the time of treatment, the fifteen year survivors an average age of 47.4 years, and the ten year survivors an average age of 51.5 years, as compared to the average age of 53.9 years in the five year survivors.

By making suitable corrections for the expected normal death rate incidental to these ages, it may be said that in carcinoma of the corpus uteri a patient who remained free of the disease for a period of five years may reasonably be considered as cured of the cancer. This fact is in contradistinction to the observations made in other types of hormone-induced cancers, where late metastases are known to occur in a considerable number of cases after the five-year period. In carcinoma of the breast, for example, a survey in a rather large number of cases made at Harper Hospital showed that one-half of the patients who were apparently cured of mammary carcinoma at the end of five years died up to the fifteen year period. Of these, 60 per cent represented death from carcinoma and only 40 per cent from other causes. In the present series of cases of carcinoma of the uterine corpus, death from recurrence or metastasis from the original lesion occurred in less than 5 per cent of the cases between the five year and twenty year periods. This may be attributed to the fact that both the terrain and source of estrogenic activity are completely removed by the hysterectomy which is nearly always associated with bilateral salpingo-oophorectomy. Even in the patients treated by irradiation alone, the local cytocaustic effect of the intracavitary radium leads to such marked destruction and fibrosis that the uterus entirely loses its functional activity. To this may be added the distant action of the radium on the ovaries which, together with the greater action of the external roentgen rays, results in a cumulative effect sufficiently strong to suspend hormonal secretion for a considerable period.

(3) *Relationship of Results to Method of Treatment in the Operable Cases.* This is illustrated in Table v. As may be seen, the five year survivors among the patients treated with method A represented 80 per cent during Period I, 80 per cent during Period II and 82 per cent during Period III, or an average of 81.2 per cent for the three periods. The corresponding rates of

TABLE IV

CARCINOMA OF CORPUS UTERI RELATION OF AGE AT TIME OF TREATMENT TO LONG SURVIVAL

Survival	Period	Cases	Average Age
20 years	1924–1930	5	45
15 years	1924–1935	20	47.4
10 years	1924–1940	59	51.5
5 years	1924–1945	133	53.9

TABLE V

CARCINOMA OF CORPUS UTERI FIVE YEAR SURVIVALS IN THE OPERABLE CASES

Period	A. Preoperative Irradiation, Hysterectomy, Postoperative Irradiation			B. Hysterectomy, Postoperative Irradiation			Total of All Operable Cases		
	Cases	Well	Per Cent	Cases	Well	Per Cent	Cases	Well	Per Cent
I 1924–1932	5	4	80	26	12	46	31	16	51.3
II 1933–1936	5	4	80	11	7	63	16	11	68.7
III 1937–1945	54	44	82	34	15	45	88	59	67.0
TOTAL	64	52	81.2	71	34	47.8	135	86	63.7

the five year survivors in the patients treated with method B were 46 per cent, 63 per cent and 45 per cent, or an average of 47.8 per cent. It may be mentioned that Kamperman[8,9] recently studied 23 personal cases of Clinical Stage I from the present series, all treated by method A, and he reported a five year survival rate of 90 per cent in this stage.

The above findings correspond to others published in the recent literature,[2,3,4,5,6,7,12,13,15] attesting to the marked superiority of method A over method B in the treatment of the operable cases of carcinoma of the corpus uteri.

The combined radium-roentgen irradiation prior to hysterectomy has, however, two additional advantages. One of these is that it permits the use of a technique facilitating an earlier diagnosis. If a woman bleeds and there is a suspicion of possible malignancy, a diagnostic dilatation and curettage is done and a radium applicator inserted into the uterine cavity. A report of the microscopic examination of the curettings is secured within forty-eight hours or less. In case of functional bleeding or polypoid endometrium, the radium dose is adjusted to the requirements of that particular condition without resorting to supplemental roentgen therapy, whereas if there is histologic evidence of carcinoma, the radius is left in situ for the full time and followed by supervoltage roentgen therapy. The other advantage is that preliminary irradiation decreases uterine size, clears up secondary infection and reduces the chances of operative infection, thus facilitating the surgical technique and almost completely eliminating postoperative complications. This latter effect was experimentally confirmed on animals by Altemeier and Jones[1] who demonstrated that if an operation is performed within four to six weeks following irradiation of the peritoneum the danger of operative infection is very slight or nonexistent.

TABLE VI

CARCINOMA OF CORPUS UTERI FIVE YEAR SURVIVALS IN THE INOPERABLE CASES

Period	C. Intracavitary Radium Therapy and External Roentgen Therapy		
	Cases	Well	Per Cent
I 1924–1932	22	7	32
II 1933–1936	19	7	37
III 1937–1945	64	31	48
TOTAL	105	45	42.8

(4) *Results Obtained by Irradiation Alone in the Inoperable Cases.* These are shown in Table VI. As may be seen, irradiation alone, usually consisting of two courses of intracavitary radium and external roentgen therapy, gave a five year survival rate of 32 per cent during Period I, 37 per cent during Period II and 48 per cent during Period III. Since the technique of the radium application had already been standardized in 1928, the only other factor which

could account for this very definite improvement in the results is the change from deep roentgen therapy to supervoltage roentgen therapy. As already stated, all patients during Period I were treated by deep roentgen therapy, those of Period II were treated in an equal proportion by deep roentgen therapy and supervoltage roentgen therapy, while the patients during Period III were subjected to supervoltage roentgen therapy exclusively. From the physical standpoint, supervoltage roentgen therapy is more advantageous for at least three reasons:[10,11] (a) it permits the administration of the required dose with less effect on the skin; (b) it makes possible a simplification of the technique through reduction of the number of portals necessary for crossfiring; and (c) because of the greater depth dose and the lesser attenuation it permits a more homogeneous irradiation of the pelvis, complementing the radium dose in a more efficacious manner.

SUMMARY AND CONCLUSIONS

From 1924 to 1945 inclusive 240 patients with carcinoma of the corpus uteri were treated at Harper Hospital by means of roentgen therapy, intracavitary radium and surgery in various combinations. A statistical analysis of the over-all results in these cases shows a very definite improvement over the years. Mainly two factors are responsible for this.

One factor is a change from deep roentgen therapy to supervoltage roentgen therapy, the effect of which is illustrated by the following figures: (1) in 53 patients treated from 1924 to 1932 by means of deep roentgen therapy the five year survival rate was 45 per cent; (2) in 35 patients treated from 1933 to 1936 in an equal ratio by means of deep roentgen therapy and supervoltage roentgen therapy it amounted to 50 per cent; and (3) in 152 patients treated from 1937 to 1945 with supervoltage roentgen therapy it rose to 60 per cent. The ten, fifteen and twenty year survival rates followed a similar pattern.

The other factor accounting for the betterment of the results is the increasingly frequent use of the preoperative irradiation with a combination of intracavitary radium and external roentgen therapy in the operable cases. The five year survival rates in the patients treated by the method of preoperative intracavitary radium plus roentgen therapy, followed six weeks later by panhysterectomy and in most instances by one or two additional courses of roentgen therapy, were for the three aforementioned periods: Period I, 80 per cent; Period II, 80 per cent; and Period III 82 per cent, corresponding to an average of 81.2 per cent. The method consisting of panhysterectomy associated with only postoperative irradiation gave for the same periods: (I) 46 per cent, (II) 63 per cent and (III) 45 per cent, or an average of 47.8 per cent. The ratio of the cases treated by the two methods was: (I) 1:5.2, (II) 1:2.2 and (III) 1.6:1. The total cases operated upon constituted (I) 58 per cent, (II) 46 per cent and (III) 58 per cent of all cases of the respective periods.

Irradiation alone, usually consisting of two courses of intracavitary radium and external roentgen therapy, gave the following five year survival rates in the inoperable cases for the three periods, (I) 32 per cent, (II) 37 per cent and (III) 48 per cent, thus furnishing additional proof of the contributory role of supervoltage roentgen therapy in the improvement of the over-all results.

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Vol. 68, No. 5

THE CAUSE, INCIDENCE AND TREATMENT OF IRRADIATION INJURIES IN THE FEMALE PELVIS*

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THE motto of this paper should be that you can't make an omelet without breaking eggs; you can't destroy cancer without using an agent which to some extent destroys the surrounding normal tissues. Obviously the attempt of the therapist will be to try to confine these destructive effects as closely as possible to the areas occupied by cancer but since none of us can tell in any given case where microscopic cancer may be, irradiation changes and occasionally necrosis are bound to follow the efforts of the conscientious and aggressive radiotherapist,

The historical progression that one observes is first gross overdosage with fistula formation in the nearby organs, then a decrease in these destructive effects, until new techniques are tried whose safe limits are not known, at which point there may be a temporary increase again in ulceration and fistula formation. As fistulae decrease one is apt to see less serious irradiation effects increase as the therapist strives to add a maximal dose without causing necrosis.

To illustrate these points from actual experience, we have studied the cases of rectovaginal and vesicovaginal fistulae occurring in the Sloane Hospital from 1917 to 1945 inclusive (Fig. 1) and the less extensive bladder and rectal complications produced at the Memorial Hospital by four different irradiation techniques.

Finally, we wish to discuss the treatment of these complications: the mild ones which yield to time or appropriate medication, and the severe ones which may necessitate surgical intervention. In regard to the latter we should like to present some statistics on an operative method of closing large vesicovaginal fistulae in patients whose vaginal tissues have been severely compromised by irradiation.

Fistulae. Radium was used first as a method of treating cancer of the uterine cervix at Sloane Hospital in 1917. The procedure followed was to dig out a hole in the cancerous tissue often with a Paquelin cautery and bury in the hole a glass tube containing 100 mg. of radium. The glass tube was enclosed in 0.5 mm. of silver and covered with a rubber finger cot. Usually at least two applications and occasionally as many as four were made commonly for twenty-four hours. As a result of this rather crude form of therapy, there were four fistulae produced, three in the bladder and one in the rectum.

In 1932 to 1934, four bladder fistulae and one rectal fistula are recorded as a result of overtreatment by external radiation therapy. This was the period during which the "saturation technique" was being tried and calibration of roentgen therapy machines in roentgens was new. Several of these patients had been treated with unknown quantities of radiation by the older techniques.

Since 1934, three fistulae have appeared which may have been produced by over irradiation, in each case by the introduction of needles. One of these cases, with cancer of the anterior vaginal wall, was treated by implantation in two planes. Another had the complication of lymphogranuloma venereum. All other fistulae have resulted from uncontrolled growth of cancer.

In all, of 725 cases of cancer of the cervix treated from 1917 to 1945 inclusive 11 developed rectovaginal fistulae and 21 vesicovaginal fistulae. One can say, then, that

* Presented at the Thirty-third Annual Meeting, American Radium Society, Atlantic City, N. J., June 7–9, 1951.

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‡ From the Memorial Hospital.

with modern techniques the large majority of the fistulae that occur are the result of invasive cancerous growth and are not attributable to therapy.

Irradiation Injuries in the Bladder. While all who treat cancer of the cervix are well aware that many patients, especially those who are clinically cured, may have hematuria and show chronic ulcers in the base of the bladder, remarkably little has been written about the causes, incidence or treatment of this complication, Dean and Slaughter[3] have described 110 patients treated in the years 1932, 1933 and 1934, and clinically free of disease at the end of five years, of whom 27 per cent had had some form of bladder distress, while 14.5 per cent had been shown to have radionecrotic ulcers. If all cases treated in these years were included, this percentage would be reduced greatly, for in our experience these ulcers develop late, usually two years or more after radiation therapy has begun, and consequently the patients who die of cancer seldom show them.

Some years ago the effect of increased doses of external roentgen therapy on the cure rate in cancer of the cervix was studied in 920 cases.[4] The records of these cases include those of 360 who were treated by so-called "massive dose" technique, a single dose of 750 r (200 kv., 50 cm. target-skin distance) to each of four 15 by 10 cm. pelvic portals There were also 136 cases treated by "divided dose technique." These patients received 200 r to each of two pelvic portals daily, through six 15 by 10 cm. fields, for a total dose of 2,400 r per field in about six weeks. The factors were 200 kv., 0.5 mm. Cu filtration, half-value layer 1 mm. Cu, target-skin distance 70. cm. A third group of 43 cases was treated by "pyramidal dose" therapy. In this group all factors were the same as with

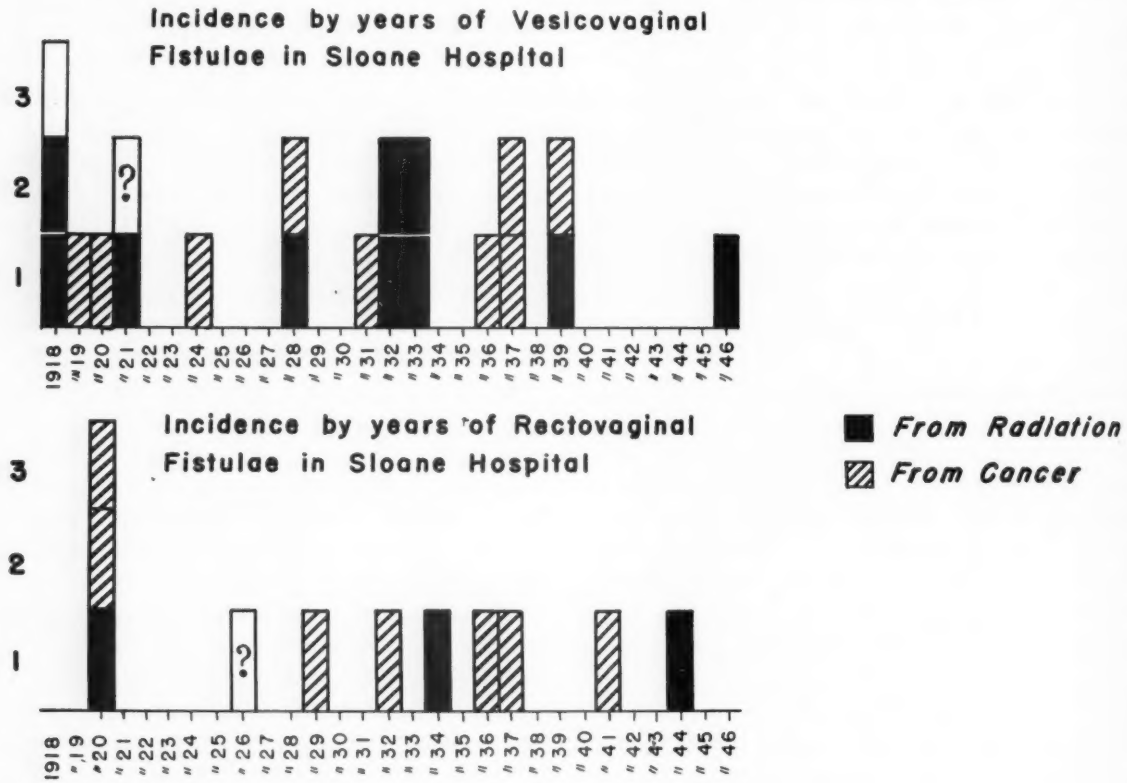
Incidence by years of Vesicovaginal Fistulae in Sloane Hospital
Incidence by years of Rectovaginal Fistulae in Sloane Hospital
From Radiation
From Cancer
FISTULAE IN CANCER OF THE CERVIX

FIG. 1

the "divided dose" treatment except the amounts given to each portal. These began with 100 r to each portal, two portals daily, and increased on each round by 50 r to 150 r, 200 r, 250 r, 300 r, 350 r and finally 350 r to a total of 1,700 r to each of six portals in about four weeks. In all the above patients external pelvic roentgen therapy was followed in a week or two by local radium therapy. This consisted of a vaginal applicator or bomb for 1,500 milligram hours, and a uterine tandem for 3,000 mg. hr. The latter consisted of two platinum-filtered radon tubes, the lower containing twice as much radon as the upper. The strength of the vaginal applicator was usually over 500 mc., the tandem varied from 100 to 200 mc., so that the radon therapy was of the short duration high intensity variety.

There is a fourth group of cases for comparison with the above three groups and this consists of 113 cases who received external roentgen therapy exactly as described for the "divided dose" cases. They also had a radon uterine tandem for 3,000 millicurie hours. They differed, however, in the replacement of the vaginal applicator by treatments with intravaginal cones. This intravaginal treatment was given with a 130 kv. shock proof machine at 25 cm. target-skin distance, 3 mm. Al filtration. The half-value layer was 4.2 mm. Al. The cones were lead lined. A cone 4 cm. in diameter was inserted to point directly at the cervix paralleled with the long axis of the patient's back and, through this, four treatments of 500 r were given. Two 3.5 cm. cones were angled out at 30° to treat each vaginal vault. Through these, four treatments of 750 r were given, or 3,000 r to each fornix. Three treatments were given each week concurrently with the external pelvic therapy and the average course of treatment occupied approximately a month.

The five year gross survival rate of these four methods of treatment was 28.5 per cent for the "massive dose" technique, 35.4 per cent for the "divided dose" technique, 32 per cent for the "pyramidal dose" technique, and 40.7 per cent for the intravaginal cone technique. This last figure, incidentally, is the highest five year cure rate for cervical carcinoma treated by radiation therapy reported from the Memorial Hospital,[2,7] and includes a 78.6 per cent survival for the Stage I cases, and 44.5 per cent survival for the Stage II cases.

In these four groups, counting all recorded bladder complaints or complications, including fistulae, there were 9 per cent of the "massive dose" cases who had bladder injuries, 16 per cent of the "divided dose" cases, 21 per cent of the "pyramidal dose" cases, and 21 per cent of the intravaginal cone cases (Table I). If one eliminates fistulae, most of which were due to advancing uncontrolled cancers, these percentages stand at 6.9 per cent. 10.3 per cent, 14 per cent, and 14.1 per cent.

In the intravaginal cone group, bladder symptoms of all varieties appeared late, averaging 28.7 months after the onset of therapy. Bladder ulcers never were seen earlier than the thirteenth month and averaged twenty-two months after treatment (Table II). (One wonders why this long latent period exists.)

Dosage calculations seem to show that with the increasing incidence of late radi-

TABLE I

BLADDER INJURIES WITH VARIOUS TYPES OF PELVIC IRRADIATION

	Massive Dose	Divided Dose	Pyramidal Dose	Vaginal Cones
No. of patients	360	136	43	113
Vesicovaginal fistulae	8	8	3	8
Bladder ulcers	11	7	2	10
Cystitis, hematuria, etc.	14	7	4	6
Total bladder complications	33	22	9	24
Per cent of all patients having complications	9%	16%	21%	21%

TABLE II

BLADDER INJURIES

113 Cases Treated by Vaginal Cones

Time in Months	Lesion in the Bladder
83	Diffuse cystitis
17	Telangectasia—hematuria
58	Telangectasia—hematuria
22	Telangectasia—hematuria
27	Hematuria
28	Hematuria
17	Ulceration 1.5 cm. deep
22	Ulceration
29	Ulceration
44	Ulceration 4 cm. deep
22	Ulceration 1 cm. deep
17	Ulceration 2 cm. deep
13	Ulceration
15	Ulceration
15	Ulceration
25	Ulceration 1.5 cm. deep
53	Vesicovaginal fistula
11	Vesicovaginal fistula

Average 28.7 months

Irradiation ulcers of the bladder developed 15 to 44 months after the first treatment. Average—22 months.

ation ulcers the dose to the bladder base itself has decreased, whereas that to the paracervical and parametrial tissues has increased. One cannot help but wonder whether the radiation ulcers in the bladder base are not really trophic ulcers perhaps as a result of irradiation to the sympathetic ganglia in Frankenhäuser's plexus rather than the result of an effect of irradiation in the trigone per se.

Our figures show very conclusively that external roentgen therapy must be counted in as part of the cause of irradiation injuries to the bladder. In the cases treated by "massive," "divided," and "pyramidal" techniques of external therapy no variation at all occurred in the amount or method of application of the intrauterine and intravaginal *radium*. Consequently the marked variation in incidence of observed bladder complications must be laid solely to the door of the various techniques of external pelvic irradiation used.

Irradiation Injuries in the Rectum. Of 360 patients receiving "massive dose" treatment, as described above, together with intrauterine and intravaginal radium, 20, or 5.5 per cent, had rectal injuries. Of 136 patients treated similarly with radium but receiving "divided dose" therapy to the pelvis, 16, or 11.8 per cent, had rectal injuries. Four of 43 "pyramidal dose" cases, or 9.3 per cent had rectal injuries. In 113 cases treated by "divided dose" external therapy and intracavitary radium, but intravaginal cone roentgen therapy instead of a vaginal radium applicator, 10, or 8.8 per cent, had rectal injuries (Table III). If one eliminates from these figures the patients who developed fistulae, since such fistulae are often the result of disease plus irradiation and may represent to some extent the conscientiousness of follow-up examinations in the clinic rather than the true incidence, the figures for rectal injury become: "massive," 8, or 2.2 per cent; "divided," 9, or 6.6 per cent; "pyramidal," 2, or 4.8 per cent; and "vaginal cones," 9, or 7.9 per cent. The time of appearance of the rectal injuries was earlier than that of the bladder injuries, averaging 11.5 months after treatment (Table IV).

Obviously, as one attempts to increase the dose to the parametria and pelvic walls, to extend the cancerocidal therapy

TABLE III

RECTAL INJURIES WITH VARIOUS TYPES OF PELVIC IRRADIATION

	Massive Dose	Divided Dose	Pyramidal Dose	Vaginal Cones
No. of patients	360	136	43	113
Rectovaginal fistulae	12	7	2	1
Rectal ulcers	2	4	1	3
Rectal bleeding, etc.	6	5	1	6
Total rectal complications	20	16	4	10
Per cent of all patients having complications	5.5%	11.8%	9.3%	8.8%

outward along the broad ligaments to the areas involved by extending cancer, the incidence of rectal injuries increases.

The same is true whether one carries this out by roentgen therapy, as we have, or by packing radium as far laterally as possible into the fornices. Not many authors have given their incidence of rectal symptoms and injuries but Baud[1] at the Curie Institute has described 9.4 per cent of mild or severe rectal symptoms occurring a year or more after treatment in 644 cases treated from 1937 to 1941.

Treatment of Irradiation Injuries of the Bladder. These may be divided into acute irradiation cystitis occurring during the course of therapy, and late irradiation injuries, which include diffuse cystitis with fibrosis, telangiectasia, hematuria, irradiation ulceration, and finally and most troublesome of all, fistula formation.

Acute irradiation cystitis is not often a very serious condition. It is apt to occur near the end of a course of external roentgen therapy and clears up rather rapidly after treatment has been stopped. Mild sedatives such as phenobarbital are often helpful; 4 cc. tincture of hyocyamus in water by mouth every four hours is a favorite remedy of long standing. If the symptoms are very severe, bladder lavage with warm saline followed by instillations of mineral oil or 2 per cent metycaine or 1 per cent novocain may be tried. In one case in our experience all these measures were of no avail and the acute cystitis continued for several months during which time the bladder capacity was reduced to 50 cc. Any attempt to introduce more than this quantity of fluid was accompanied by acute pain and strangury. So painful were the symptoms that they required demerol and finally pantopon for their control, though they finally cleared up without further specific treatment.

Late irradiation effects in the bladder may first be manifest as sudden painless hematuria. In some cases cystoscopy may show only diffuse mucosal atrophy or telangiectasia over the bladder base. Occasionally one may be able to identify the bleeding point and control it by local fulguration. Often the bleeding is not severe enough or persistent enough to require any treatment.

Table IV

RECTAL INJURIES

113 Cases Treated by Vaginal Cones

Time in Months	Lesion in the Rectum
7	Proctitis
8	Bleeding
13	Bleeding
26	Bleeding
8	Bleeding and stenosis
10	Bleeding and stenosis
12	Bleeding and stenosis
8	Stenosis
12	Stenosis
11	Rectovaginal fistula

Average 11.5 months

Irradiation ulcers in the bladder base are best treated by appropriate antibiotics. The urine in these patients, if they have symptoms, is always infected and one should use a medicine to which the particular organism can be shown to be sensitive. Dean and Slaughter reported that in most cases sulfathiazole in doses of 1.0 gm. every four hours for a week was very effective. Recently gantrisin, 1 gram every six hours, has been used more routinely because of its greater solubility in urine.

The peculiar feature of this type of treatment is that, while antibiotics seem to eliminate the patient's symptoms so that she no longer complains of pain, frequency, or urgency, they do not bring about these improvements by healing the ulcer. So one may have a patient with no complaints who on cystoscopy may show a most alarming lesion perhaps 3 or 4 cm. in diameter. Experience shows that in time almost all of these ulcers heal spontaneously.

One very important point is that the urologist should be familiar with their appearance. Otherwise bladder resections may be done unnecessarily in spite of negative

biopsies. Occasionally the pathologist may report cancer in such cases where the appearance is really that of transitional epithelium regenerating in the irregularities of an ulcer. Frequently one must warn the pathologist of the likelihood of an irradiation ulcer and urge him to be absolutely certain of his opinion before making a positive diagnosis of cancer.

Vesicovaginal fistulae due to radiation therapy are fortunately very rare. In the Sloane Hospital as mentioned above from 1917 to 1946, of 725 cases of cancer of the cervix seen and treated, only 10 developed fistulae which could be attributed to the irradiation. In 1944 it was the misfortune of one of the authors of this paper to see such a case develop under his care as a result of, first, repeated radium and roentgen therapy which failed to control a carcinoma of the cervix of rather limited extent and, second, a subsequent radical hysterectomy which resulted, apparently, in a definitive cure. While all the cancer had been removed by surgery, the combination of surgery and radiation therapy resulted in an area of avascular necrosis in the middle of the trigone, which ultimately fell out, leaving a hole about 1.5 cm. in diameter just between the ureteral orifices.

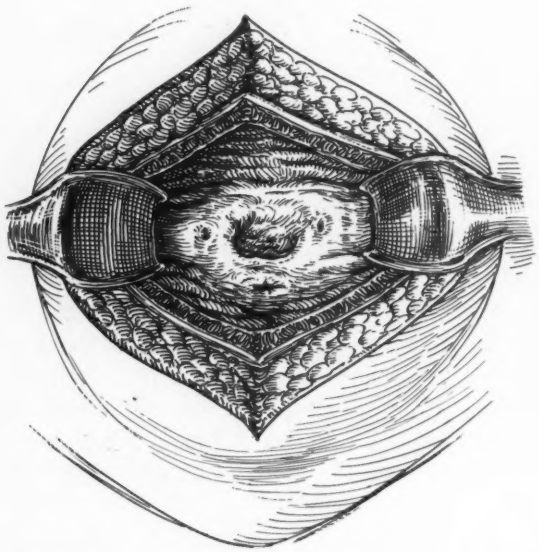

FIG. 2. Drawings in Figures 2 to 7 show steps of operation used to close vesicovaginal fistula due to radiation therapy. This illustration shows a typical fistula in the center of the trigone as seen at operation through a suprapubic cystostomy.

To close this fistula a new procedure was devised with the help of Dr. Victor F. Marshall.[6] This consisted of (1) a suprapubic cystostomy with expsoure from above of the fistula, and a marking out of a patch of mucosa on the posterior wall of the vagina the size and shape of the fistulous opening; (2) with the patient in lithotomy position, denudation of the upper one-half to one-third of the vagina of its mucous membrane, leaving the patch on the posterior vaginal wall undisturbed; (3) suture of the anterior and posterior walls of the vagina, together with interrupted stitches at the cut edge of the mucosa; (4) fastening the patch into the fistulous opening with several interrupted stitches through the cystostomy opening; (5) complete drainage of the bladder by suprapubic catheter for two to three weeks by making the patient lie on her stomach or by constant gentle suction through a suprapubic tube going to the bladder base. The steps of this operation are understood best perhaps by study of the accompanying drawings (Fig. 2–7).

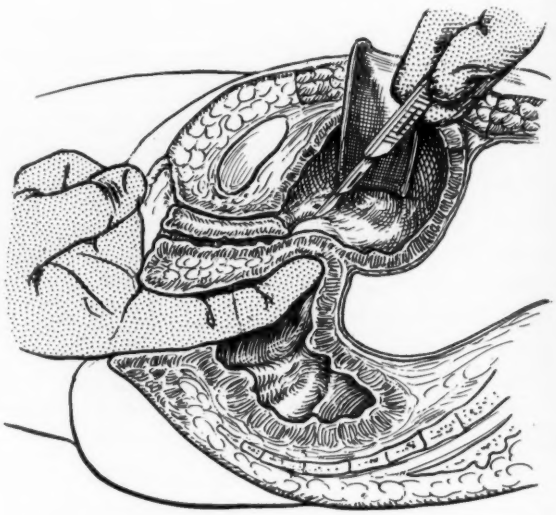

FIG. 3. The vaginal patch on the posterior wall of the vagina is outlined through the bladder.

To date this procedure has been used at the Sloane Hospital, the Memorial Hospital, and the New York Hospital on 15 women. In 4 of these the fistulae were attributable to radiation therapy, in 7 they were due to radiation therapy plus surgery, usually radical hysterectomy, and in 4 they were the result of surgical accidents alone. Of the 15 cases, 10 had complete relief of incontinence with no serious subsequent genitourinary symptoms. One had

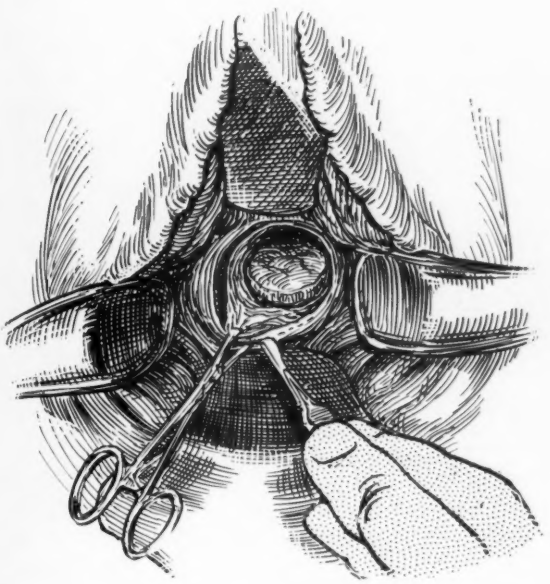

Fig. 4. The upper third of the vagina is denuded leaving the patch in place.

a complete failure of the repair to heal; the irradiation damage was too widespread and the avascularity of the tissues too marked. In 4 cases there was stress incontinence after the operation, or secondary operations were necessary, or in 1 case, recurrent cancer opened new fistulous tracts.

Treatment of Irradiation Injuries of the Rectum. The most acute complications in the treatment of cancer in the female pelvis are those due to acute irradiation proctitis. Some degree of diarrhea is a very frequent result of heavy external radiation therapy but when this is accompanied by tenesmus, mucus, or the passage of blood, it may become of major importance. Stopping treatment usually promptly alleviates the symptoms. Often this is undesirable and one proceeds with the outlined therapy, tiding the patient over with frequent doses of bismuth, or paregoric, or with soothing, rectal irrigations and the instillation of olive oil.

The later and more serious injuries of the lower gastrointestinal tract are of two kinds. The first of these fortunately

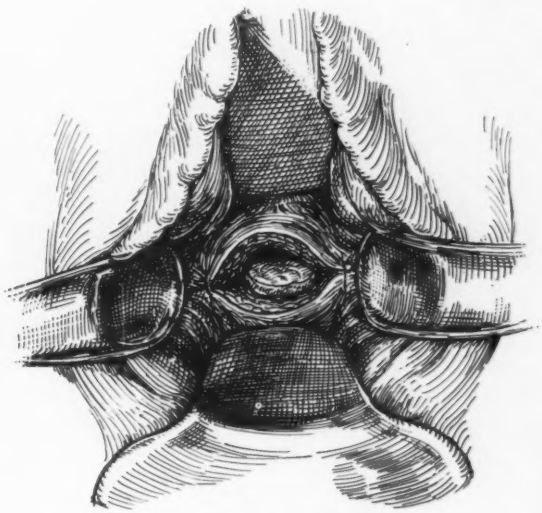

Fig. 5. The edges of the vaginal mucosa are united transversely.

is rare. It consists of irradiation necrosis of a loop of bowel which usually has been caught down in the posterior cul-de-sac and held there by adhesions. Typically the symptoms are those of chronic intestinal obstruction with subsequent localized peritonitis. The treatment, of course, is surgical resection of the damaged bowel and anastomosis. The injured loop usually shows a thickened and edematous wall but the striking feature, as with other types of irradiation damage, is the lack of vascularity of the viscus, and arteriolar sclerosis with subsequent fibrosis and necrosis. In 652 cases, this sort of damage was seen 6 times.

Perhaps more troublesome because more common is the chronic proctitis which

makes itself evident by rectal bleeding, persistent diarrhea, and distressing rectal pain and tenesmus. In our experience, rectal irrigations with 1:2,000 potassium permanganate has been most helpful in these complications. Ultimately, almost all seem to heal spontaneously, though one patient required seventeen transfusions to keep her blood count somewhere within normal range before this occurred.

Recently we have had occasion to do a

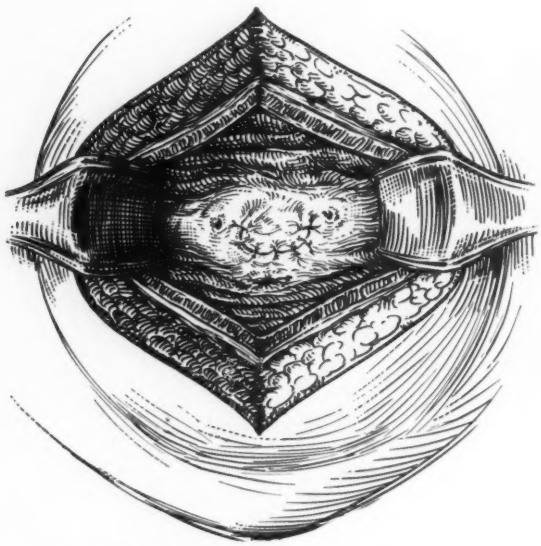

FIG. 6. The patch is held in place in the bladder base with several interrupted stitches.

temporary loop colostomy on such a patient who recovered though not immediately. Evaluation of the usefulness of this procedure is difficult. It seems a logical step in any case presenting serious uncontrollable chronic rectal hemorrhage.

Johnston and Jacox[5] in 1948 reported a case in which they had resorted to rectal resection to control bleeding following irradiation. So far we have not found such a radical procedure necessary but perhaps it should be tried more frequently. Perhaps a permanent colostomy is a better thing to have than a year's invalidism with constant pain, bleeding, rectal mucus and 17 transfusions!

SUMMARY

Rectovaginal or vesicovaginal fistulae occur most frequently as the result of the uncontrolled growth of cancer of the uterine cervix. Those attributable to radium and roentgen therapy are due to the faulty application of these agents with either too high a dose in a small area, too high intensity over a short time, or repeated treatment of recurrences in areas which have already received heavy doses of radiation.

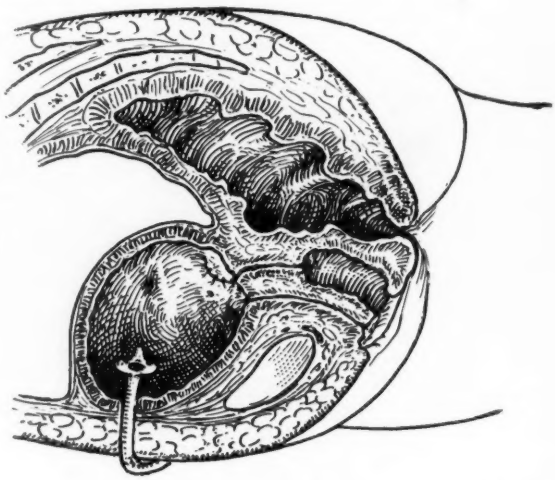

FIG. 7. The finished colpoclysis and repair with the patch is seen in sagittal section. The patient is on her stomach with suprapubic drainage in which position she is kept until healing takes place.

Of 725 cases of cancer of the cervix treated at the Sloane Hospital from 1917 to 1945, thirteen developed fistulae which could be attributed to irradiation, ten being vesicovaginal and three rectovaginal.

In three series of cases treated at the Memorial Hospital, in which the radium application was kept uniform, bladder injuries varied from 9 to 21 per cent, depending upon the total amount of external irradiation reaching the parametria. The highest rate of injury was found in a fourth group showing the highest rate of cure, 113 cases treated by multiple small doses of external roentgen therapy to six pelvic portals, multiple treatments through the vagina in three directions and a radium

tandem for 3,000 milligram hours; 40.7 per cent survived five years, 78.6 per cent of those classified as League of Nations, Stage I, and 44.5 per cent of those in Stage II. In this group there were ten radiation ulcers of the bladder, and six cases of hematuria or chronic irradiation cystitis.

Rectal injuries also varied with the dose of external roentgen therapy from 5.5 per cent to 11.8 per cent; the more aggressive the treatment, the higher the rate of complications.

Bladder ulcers heal with time; the symptoms are relieved in most cases by appropriate antibiotics. Fistulae are usually closed successfully by a plastic operation previously described, a vaginal patch in the defect plus colpocleisis. Fifteen such cases have been done.

Intestinal injuries include infrequent damage to the colon and small intestine, the treatment of which requires major intestinal surgery, and proctitis with or without ulceration. Potassium permanganate irrigations are of considerable benefit for chronic proctitis. Severe and prolonged bleeding may require colostomy, or even rectal resection.

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A DIRECT CURRENT AMPLIFIER RECORDING SYSTEM FOR PRECISE MEASUREMENT OF DEPTH DOSE

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INTRODUCTION

THERE has long been a need for a rapid and accurate method of measuring percentage depth dose. Methods using condenser ionization chambers are tedious because of the time required to take individual measurements. Instantaneous methods involving the use of direct current amplifiers have been used in a number of investigations,[1,3,4,7] and have proved to be reasonably satisfactory. However, difficulty is experienced in obtaining accurate results since rapid variations of roentgen-ray intensity are common to all types of roentgen-ray generating equipment.

The ratio of the dose received at P, a point on the axis of a roentgen-ray field in a phantom, to the dose received at S, the center of the field on the surface, expressed as a per cent, is defined as the percentage depth dose. Accurate and rapid measurement of this ratio therefore involves: (a) the use of an electronic circuit which measures directly the ratio of two ionization currents, or (b) the instantaneous measurement of the dosage rate at P when the dosage rate at S reaches a definite value, or (c) the simultaneous measurement of the dosage rate at P and the dosage rate at S.

Method (a) has been used with considerable success by Kemp[6] using two identical small ionization chambers, one of which is kept at the surface of the phantom, while the other is lowered along the field axis. The ratio of the two ionization currents is read directly from the setting of a condenser.

Method (b) has been used by a number of investigators and requires two operators. The output of the D. C. amplifier is read at the instant the roentgen-ray intensity assumes the value it had when the surface reading was taken. With this method accuracies to within 1 per cent are hardly obtainable.

Method (c) involves the simultaneous measurement of the dosage rate at P and the dosage rate at S over a convenient period of time and has been made possible by the use of recording systems. This method is accurate to better than 0.5 per cent and has been used in obtaining a comprehensive set of depth dose data for the 150–400 kv. energy region.[5] Details of method (c), including the design of amplifier circuits and auxiliary apparatus, will be discussed in this paper.

METHOD OF OBTAINING MEASUREMENTS OF PERCENTAGE DEPTH DOSE

Figure 1 shows a block diagram of the experimental arrangement. Permanently mounted in the head of the roentgen machine is a large ionization chamber M. This is connected to a monitor amplifier whose output is presented on a recorder. A typical trace of the varying output is shown on Chart I in Figure 1. The small ionization chamber at P is connected through a pre-amplifying stage to a sensitive D. C. amplifier. The output from this amplifier is fed into another recorder. Chart II in Figure 1 shows the type of trace obtained for successive depths of 1 cm. A selsyn motor arrangement operated by remote control lowers the probe in the water phantom. The position of the probe

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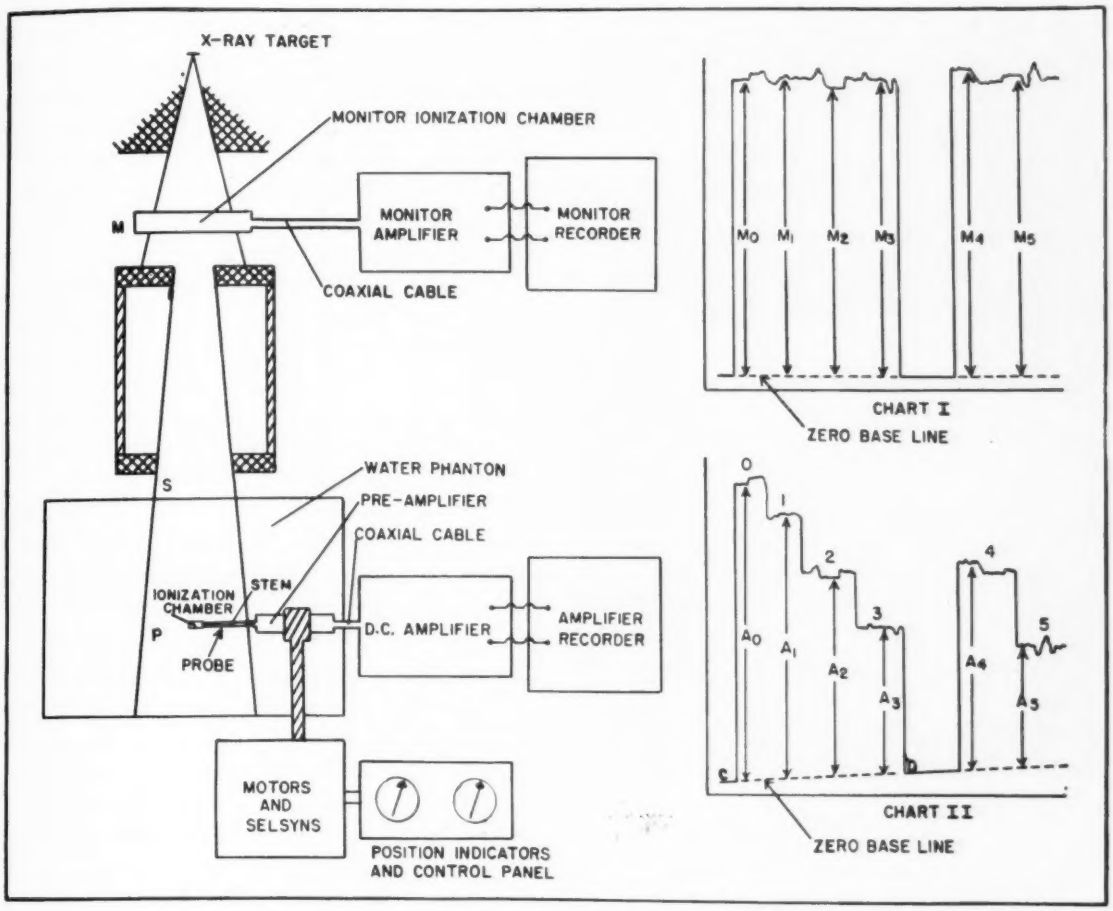

FIG. 1. Block diagram of apparatus used in measuring depth dose.

is recorded at all times on the position indicators.

To make depth dose measurements, the small ionization chamber is first accurately positioned on the surface of the water phantom. The roentgen machine is turned on and the sensitivities of both amplifiers are adjusted for full scale deflections on both recorders. After a short length of time during which the recorder pens trace the varying dose in a corresponding manner, the probe is lowered in 1 cm. steps below the surface of the water, and traces are obtained at each depth as indicated on Chart II. When the deflection on this chart drops below 50 per cent of its full scale value, the roentgen machine is turned off and the zeros of both recorders are traced. The sensitivity of the D. C. amplifier is now doubled so that a full scale deflection is again obtained on the amplifier recorder and traces are made for greater depths. This procedure is repeated when again the deflection falls below 50 per cent.

Comparison of the two traces now enables the percentage depth dose to be computed. The zero position of the amplifier to be described later varies linearly with time. This allows the zero position of the recorder at any instant to be interpolated by drawing in the dotted line CD (see Chart II). Deflections A_0, A_1, A_2, etc., are measured from this line. For purposes of illustration, the slope of the line CD has been exaggerated. It is evident that the percentage depth dose D_1 at a depth of 1 cm. is given by

$$D_1 = 100\frac{A_1}{A_0}\times\frac{M_0}{M_1}.$$

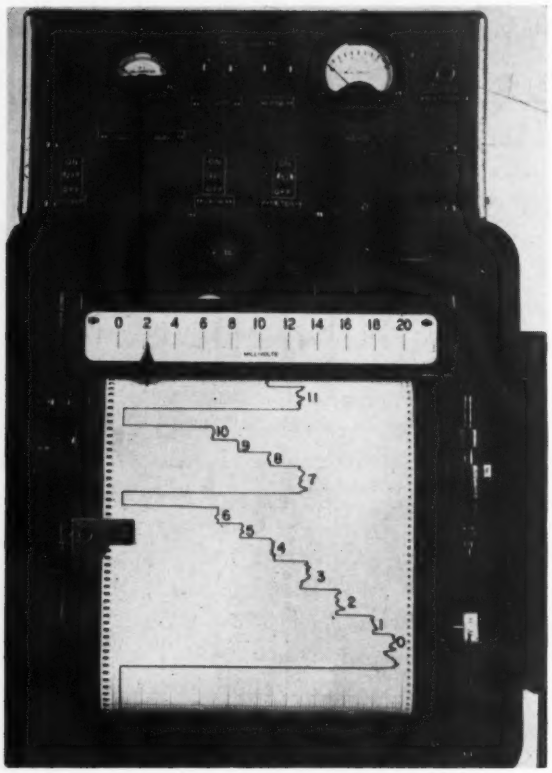

FIG. 2. Photograph of Leeds and Northrup pen-recorder and D. C. amplifier.

In practice it is convenient to hold the output of the roentgen machine as constant as possible so that M_1, M_2, etc., differ only by small amounts from M_0 making the corrections due to output variation small.

Identical recorders manufactured by Leeds and Northrup Co. were used. A photograph of the D. C. amplifier and its recorder with an actual trace is shown in Figure 2. The sensitivity of the amplifier was doubled after a depth of 6 cm. and quadrupled after a depth of 10 cm. It is evident from this trace that rapid variations of output occur even when an effort is made to hold the output constant.

The recorder gives a full scale deflection of 10 inches for an input signal of 20 millivolts. It is rapid in response to input signal, the pen requiring 1.5 sec. to travel the full width of the chart. For small changes in input signal, the response is very rapid. The recorder is essentially a self-balancing potentiometer in which a D. C. input signal is compared with a reference voltage supplied by a standard cell incorporated in the instrument. If the two voltages are

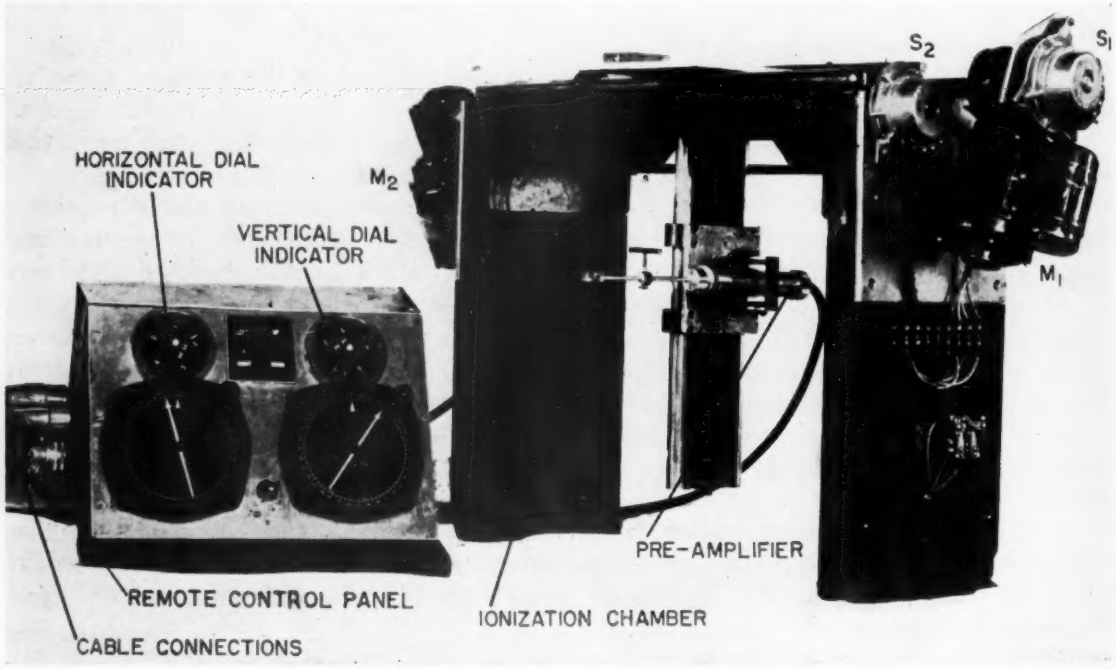

FIG. 3. Photograph of probe-positioning apparatus with control panel.

different, the instrument recognizes the condition of unbalance, determines its magnitude and direction, and moves the position of a slidewire contactor to which the pen is attached until the difference disappears. The recorder is linear in operation and input signals can be recorded to an accuracy of 0.2 per cent for full scale deflection.

Figure 3 is a photograph of the selsyn motor arrangement used for positioning the probe in the water phantom. The ionization chamber and stem connected to the pre-amplifier are shown in position. The probe is fastened to a plate which can be moved vertically on runners by a threaded rod. This rod is driven through a right angle drive by motor M_1. The selsyn generator S_1 transmits the number of revolutions of the threaded rod to the control panel where the position of the probe is indicated by the dials on the right. The motor M_2 moves the probe in a horizontal direction, the position of the probe being indicated by the dials on the left. Motors M_1 and M_2 are two-phase motors and can be reversed under load. The probe may be positioned to an accuracy of 0.1 mm.

THE PROBE

The probe consists of a small ionization chamber connected to a pre-amplifier. A flat ionization chamber for depth dose measurement is described in another paper.[5] Figure 4 is a scale diagram of a cylindrical ionization chamber used for the investigation of effects at the edge of a roentgen-ray beam and for the measurement of isodose distributions. A carbon coating on the interior of the lucite cap makes contact with an aluminum ring which in turn makes contact with a bared portion of the insulated wire *W*. This wire is maintained at 15 volts above ground. A lucite ring serves to insulate the aluminum ring from the grounded aluminum case. Centered in the air volume is an aluminum wire which acts as the collecting electrode. Both the aluminum wire and the insulated wire are attached to male connecting pins which may be connected to the pre-amplifier.

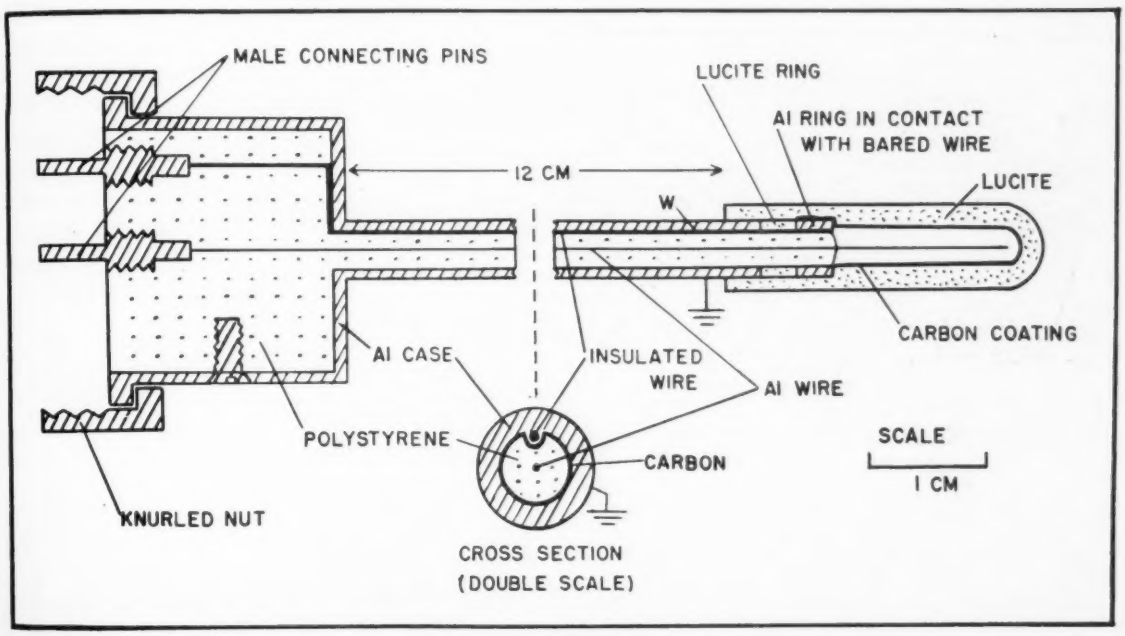

Fig. 4. Scale diagram of cylindrical ionization chamber.

The ionization chamber is connected to the pre-amplifier by a stem 12 cm. long. This serves to eliminate the presence of a large scattering mass in the immediate vicinity of the ionization chamber. A cross section of the stem drawn to double scale is also shown in Figure 4. Two precautions are taken for the reduction of undesired ionization in the stem. First, the polystyrene stem enclosing the aluminum wire is made in a special way. Lengthwise grooves are cut in the faces of two polystyrene pieces. The wire is inserted between the two pieces which are then cemented together. After the cement has hardened, the stem is machined round. This procedure reduces the size and number of small air volumes about the aluminum wire. Second, the polystyrene stem and the groove for the wire *W* are completely coated with carbon which makes contact with the outside aluminum case (see cross-section view, Fig. 4). This completely shields the collecting electrode from the wire *W*. Furthermore, the aluminum wire is held at about the same potential as the outer grounded aluminum case. Thus, ions produced in air volumes still present in the stem will not be collected because they are in a "field free" region.

The small current from the ionization chamber is passed through a 10^{11} ohm resistor which acts as the input resistor to a Victoreen 5800 tube connected as an electrometer. The operating voltages for the electrometer tube are rather critical as discussed by Victoreen[8] and are shown in Figure 6.

The tube and resistor are housed in the pre-amplifier, as shown in Figure 5. Insulation about the grid *G* of the 5800 must be kept very high and air cavities must be excluded from this region. Both these requirements are achieved by filling the space about the electrical components with ceresin wax. The mechanical design of the pre-amplifier differs considerably from that previously reported.[2] The polystyrene plug *P* on the right holds two female pins into which the male connecting plugs from the ionization chamber fit. The multi-wire shielded cable on the left is held firmly in the aluminum base *A*. An aluminum case *B*, made in two halves, is fastened to base *A* and plug *P* by screws *S*. The top section

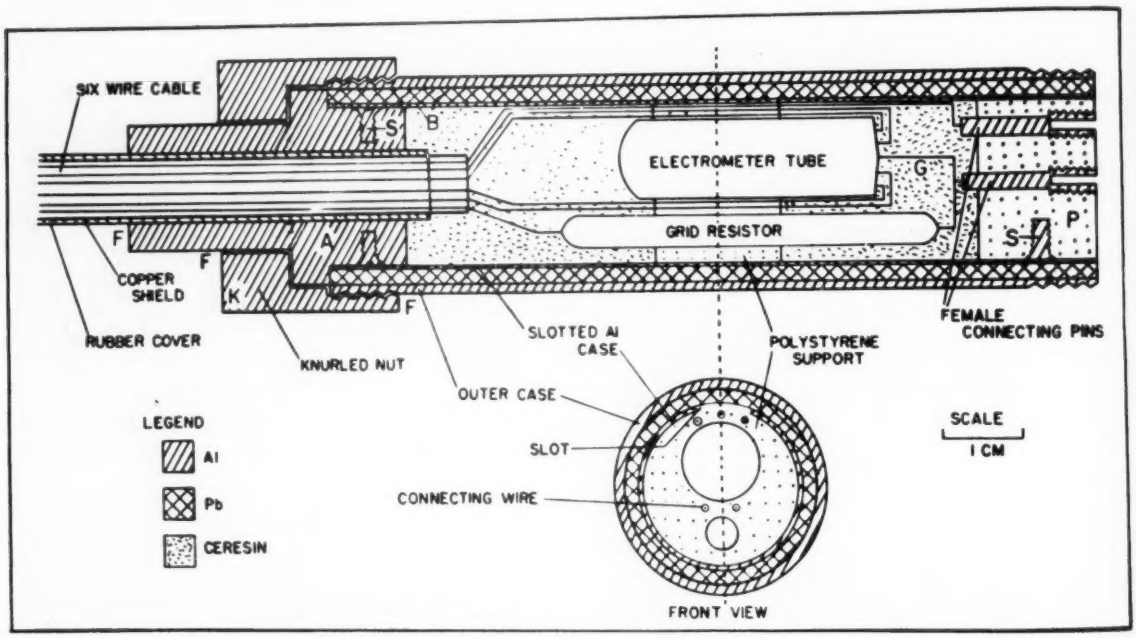

FIG. 5. Scale diagram of pre-amplifier.

of the case is slotted. This half is removable so that electrical components may be placed inside. After wiring is completed, the top section is replaced and hot ceresin wax is poured through the slot completely filling the cavity. The case *B* is now inserted inside a cylindrical sheath consisting of 2 mm. of lead and an outer aluminum case. The knurled nut *K* holds the unit together. The pre-amplifier can be water-proofed by application of rubber cement at joints *F*. With this design, undesired ionization in the pre-amplifier is minimized and radiation shielding of the 5800 tube is achieved. Furthermore, the unit may be readily assembled and disassembled.

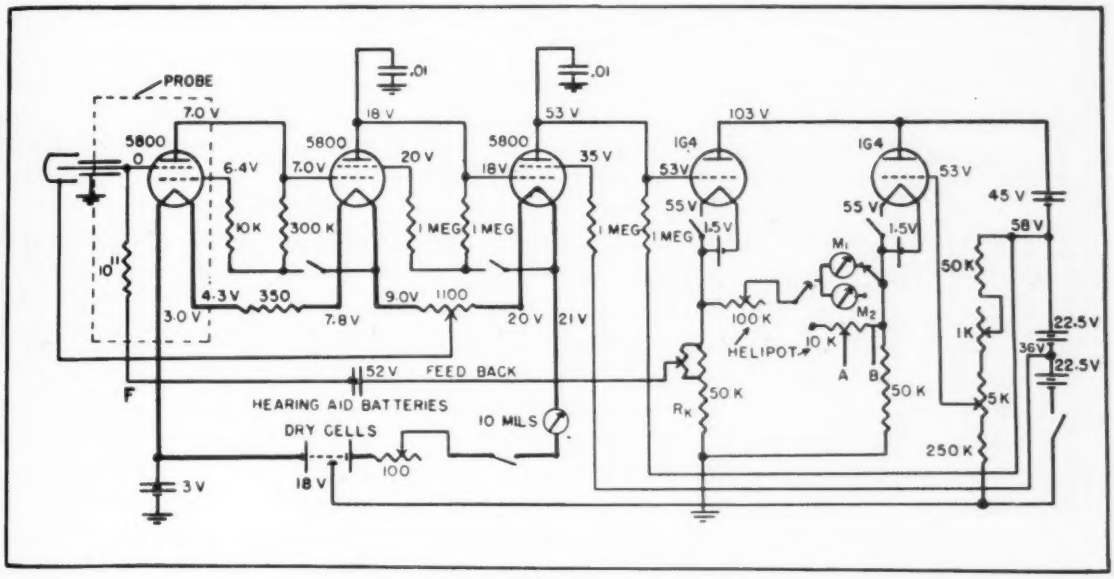

FIG. 6. Circuit diagram of D. C. amplifier.

THE AMPLIFIER

A circuit diagram of the D. C. amplifier is shown in Figure 6. The circuit is similar in principle to the one previously designed by some of the authors.[2] However, the circuit presented here is battery-operated and is much simpler to build. Twelve 1.5 volt No. 6 dry cells in series supply 10 milliamperes to the bleeder chain and to the filaments of the three 5800 Victoreen tubes. The bleeder chain appears as a heavy line in Figure 6. The resistors in the chain are wire-wound and have a high power rating. The first 5800 tube is housed inside the pre-amplifier as described above. It performs the usual functions of an electrometer tube.[8] The other two 5800 tubes are used as tetrode voltage amplifiers. Plate and screen supplies for the first two tubes are taken from appropriate points on the bleeder chain. The use of a single battery to supply the filaments and to provide the plate potentials tends to minimize zero drift. The operating voltages for the three 5800 tubes are marked on Figure 6. The switches shown in Figure 6 are ganged and so arranged that the filaments of the three 5800 tubes are heated before positive potentials are applied to the screens and plates. This prevents destabilization of the 5800 tubes.[8]

Two battery operated 1G4 triodes employed as cathode followers make up the output stage of the amplifier. Separate 1.5 volt batteries, heat the filament of each tube. One 45 volt and two 22.5 volt "B" batteries supply the plate voltage. With cathode resistors of 50 K the current per plate is about 1 milliampere.

All of the output voltage of the amplifier is fed back out of phase with the input sig-

nal to point F, the lower end of the 10^{11} ohm resistor. This is achieved through the use of hearing aid batteries and a potentiometer in parallel with a portion of the cathode resistor RK. Negative feedback is used in the D. C. amplifier for the following reasons: (1) it ensures linearity of the circuit; (2) it enables the circuit to handle large input signals; (3) it makes the circuit essentially independent of tube characteristics; (4) it reduces the time constant of the input signal by the factor G where G is the gain without feedback. The D. C. amplifier has a gain without feedback of about 100.*

The output from the amplifier (*i.e.*, the cathode to cathode voltage of the 1G4 triodes) may be measured with either a microammeter or a recorder by use of a selector arrangement shown in Figure 6. Either a 0–100 microammeter M_1 or a 0–25 microammeter M_2 may be chosen. The resistances of meters M_1 and M_2 are made equal so that M_2 may be used instead of M_1 without change in the calibration. Once the deflection on M_1 falls below 25 microamperes, M_2 may be switched into the circuit. The sensitivity of either meter is altered by adjustment of the 100 K rheostat. Alternately, the output may be measured by placing a recorder across terminals AB. The sensitivity is now altered by varying the setting on the 10 K helipot. After the circuit has been warmed up, the zero drift for no input signal is about 1 millivolt/min. In one minute this amounts to about 1 per cent of full scale deflection on M_2 when the amplifier is set for maximum sensitivity (*i.e.*, only the meter resistance between the two cathodes). This drift is constant with time and may be corrected for on a recorder chart as has previously been discussed. In comparison with the magnitude of the input signals usually measured, the effect of zero drift is very small.

In order to investigate the effect of battery voltage changes on output voltage. artificial changes were introduced in each battery in turn. A 1 millivolt change in output voltage was separately caused by (1) a 5 millivolt change in battery voltage across the bleeder chain, (2) a 13 millivolt change in battery voltage supplying the filaments of the 1G4 triodes, and (3) an 18 millivolt change in the plate supply to the final 5800 tube. Thus the output of the amplifier is most sensitive to current changes in the bleeder chain. For this reason, large No. 6 dry cells were used as the battery supply for the bleeder chain.

The linearity of the amplifier was checked by two independent methods. One method assumed the validity of the inverse square law as applied to the beam from a roentgen machine. The other method consisted of inserting known voltages in series with the feedback lead. No deviation from linearity could be detected in either case.

MONITOR

Figure 7 shows a circuit diagram of the battery-operated monitor circuit. Because the monitor ionization chamber is large in volume, no pre-amplifier is required. The input signal is fed into a circuit identical with the output stage of the amplifier. A bank of input resistors and condensers serves to vary the magnitude of the input signal and time constant of the circuit. It is very important that the time constants of the D. C. amplifier and monitor amplifier be made the same. The recorder is inserted across terminals AB.

TYPICAL RESULTS

With the apparatus described it is possible to measure the depth dose from a roentgen machine to an accuracy of 0.5 per cent. In Table 1 is shown the depth dose

* Since the circuit of Figure 6 was designed and used considerable simplification has been made possible in the circuit. When the 5800 electrometer tube is used it must be followed by at least three tubes to obtain sufficient loop gain and the right phase relations in the output stage for negative feedback. Recently Raytheon have developed two new tubes the CK5886 and the CK5889, either of which can be used as a pentode electrometer to give gains of up to 300 with grid currents nearly as small as are present with the Victoreen 5800 tube. Using the Raytheon tubes the amplifier need only consist of two tubes—the electrometer tube and a cathode follower. This circuit is much simpler, lighter and operates equally well. Details of the circuit will be found in a later publication.

Table I

Half value layer	0.955 mm. Cu
Focal-skin distance	50 cm.
Area	200 cm.^{2}

Depth (cm.)	Percentage	Depth Dose
0	100.0	100.0
2	96.3	96.3
4	80.5	80.4
6	64.9	65.1
8	50.0	49.8
10	38.0	37.9
12	28.8	28.7
14	21.7	21.6
16	16.0	16.0
18	11.8	11.9
20	8.8	8.8

obtained from a roentgen-ray beam of quality 0.955 mm. of Cu for a 200 cm.^{2} field at a focal-skin distance of 50 cm. The second column gives the depth dose computed from the recorder charts. The third column gives the values read from the curve best fitting these experimental points. It is seen that in general the two columns agree to better than 0.5 per cent. Without using the recorders it is difficult to get agreement to within 1 per cent. Accuracy to 0.5 per cent is necessary for investigation of the variation of depth dose with focal-skin distance.

The recorder method has been used in bringing out a comprehensive set of depth dose data for the 150–200 kv. energy region. These and data for other energy regions are presented in a paper in publication.[5]

CONCLUSIONS

A method for the measurement of depth dose using pen-recording systems has been developed. With this equipment, difficulties arising from the rapid fluctuation of the output from a roentgen-ray machine may be overcome. Depth dose may be measured to an accuracy of 0.5 per cent.

The D. C. amplifier with its associated probe described in this paper has proved to be a versatile piece of equipment in a radiotherapy department. Various kinds of ionization chambers have been built for use with the amplifier. These include a flat chamber for depth dose measurement,[5] a cylindrical chamber for investigation of isodose distribution (Fig. 4), and chambers

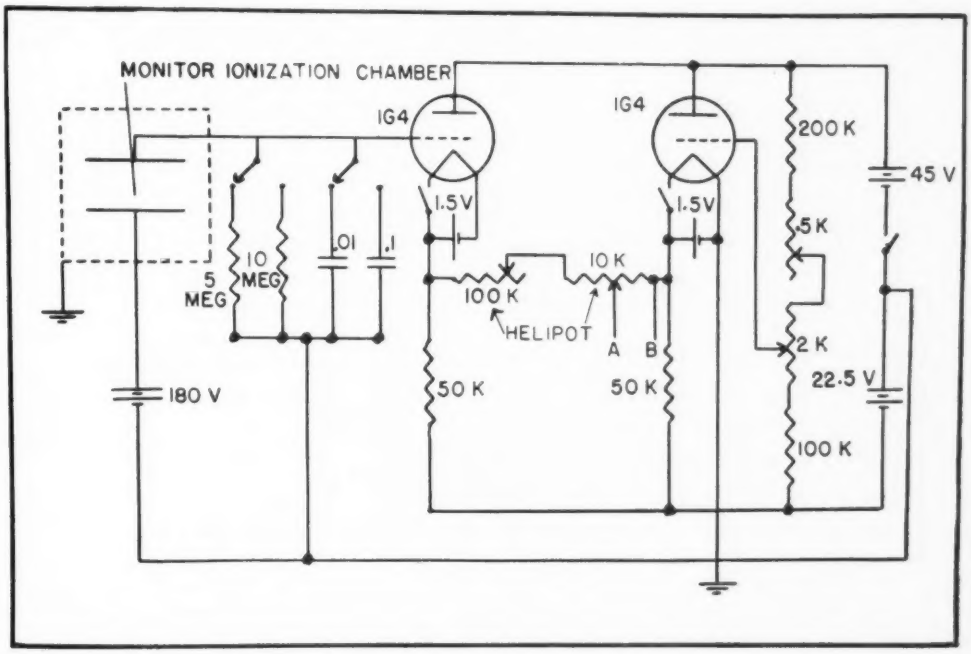

Fig. 7. Circuit diagram of monitoring circuit.

of larger volume for stray radiation and radium measurements. The amplifier has been used in problems other than the measurement of depth dose. These include investigation of isodose distribution, measurement of percentage backscatter, measurement of attenuation of cobalt gamma rays, investigation of radiation distribution on the surface of cobalt breast applicators and investigation of radiation distribution from beta-ray applicators.

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The authors wish to acknowledge the support which has been received from the National Cancer Institute of Canada and the Saskatchewan Branch of the Canadian Cancer Society. Thanks are due to Mr. A. H. Cox of the Physics Department for his careful machine shop work.

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ROENTGEN THERAPY DOSE COMPUTING DEVICE, ESPECIALLY FOR ROTATION THERAPY WITH HIGH ENERGY (2 MEV.)

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THE principle of the instrument described herein is based on the method for dosage computation and its application to 2 mev. rotation roentgen therapy developed by Dr. J. G. Trump and his associates,[5,6] High Voltage Engineering Laboratory at the Massachusetts Institute of Technology. The instrument is also useful for other roentgen radiation techniques.

Two important factors in the calculation of dose at any particular point in a body section are the tissue absorption of the beam and the distance of the point from the beam source. The absorption of a 2 mev. roentgen-ray beam (10 by 10 cm. field size) as a function of the tissue depth is shown in Figure 1.[5] This curve is, of course, different for every other roentgen-ray energy and field size.

In the application of rotational or multiportal therapy, the tumor is generally considered as centered on the axis of rotation. The amount of dose received at the rotation center, C, is dependent on the thickness of absorbing tissue material surrouding C (Fig. 2). The distance from target T to center of rotation remains constant.

If the point P at which the dose is to be calculated is not coincident with the center of rotation, the dose computation is more complicated. The distance from target T to point P changes with the rotation of the body. During a rotation the point P moves both closer and farther away from the target relative to C (Fig. 2). The intensity of the radiation obeys the inverse square law and changes therefore at point P according to the function

$$\frac{(TC)^2}{(TC \pm \delta)^2}$$

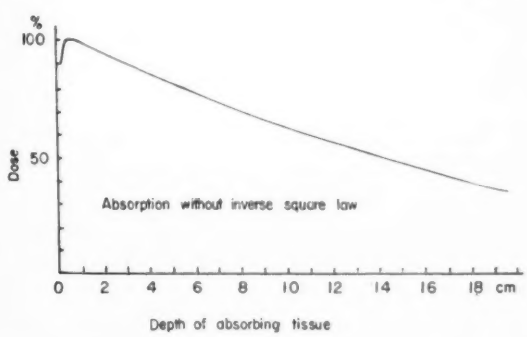

Fig. 1. Absorption curve of a 2 mev. roentgen-ray beam in tissue-equivalent material (10 by 10 cm. field).

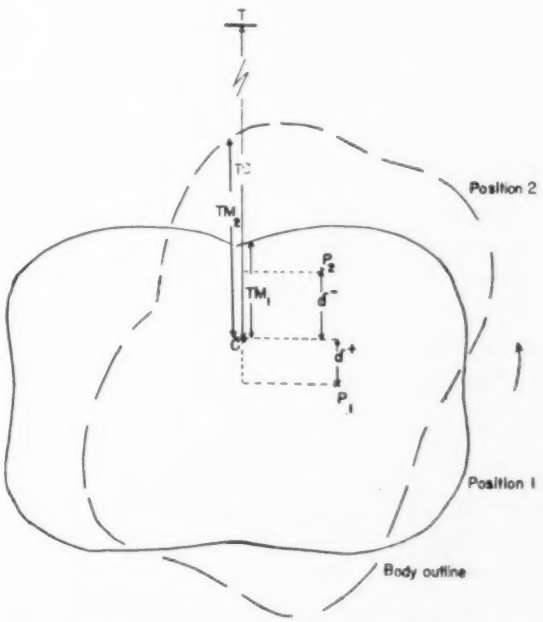

Fig. 2. Variation of distance δ of a point P in front of or behind the center of rotation C and the intervening tissue TM during rotation.

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where δ is a function of the angle α of the rotating body.

$$\delta = CP \cos \alpha = 2r \cos \alpha.$$

The distance of the center of rotation C to the target of the roentgen tube is known (in Fig. 2 this is 122.5 cm.). Therefore the distance of point P to the target at any angle can be found by subtraction of the distance δ from the total distance C-target. δ is negative, as in Figure 3, if it lies closer to the target than C, and is positive if it is farther away. The parameter for the series of curves shown in Figure 3 is the absorbing tissue depth. The abscissa represents the distance δ in front of (−) or behind (+) the center of rotation. The ordinate at any point of intersection between the appropriate curve of tissue depth and the distance δ indicates the depth dose in per cent at that point.

In order to compute the average dose $\overline{D}_P$ at point P during one complete revolution of the body, by integrating from 0° to 2π

$$\overline{D}_P = \frac{\int_0^{2\pi} D_P d\alpha}{\int_0^{2\pi} d\alpha}$$

the following approximate prodedure is used.

The thickness of the absorbing tissue and the distance δ must be measured for different beam angles. From these data the percentage of the depth dose for each angle will be found with the help of the curves of Figure 3. The sum of these dose readings divided by the number of angles used gives the average dose $\overline{D}_P$. If P is not always within the irradiating field, only the dose for the beam angles including P are taken.

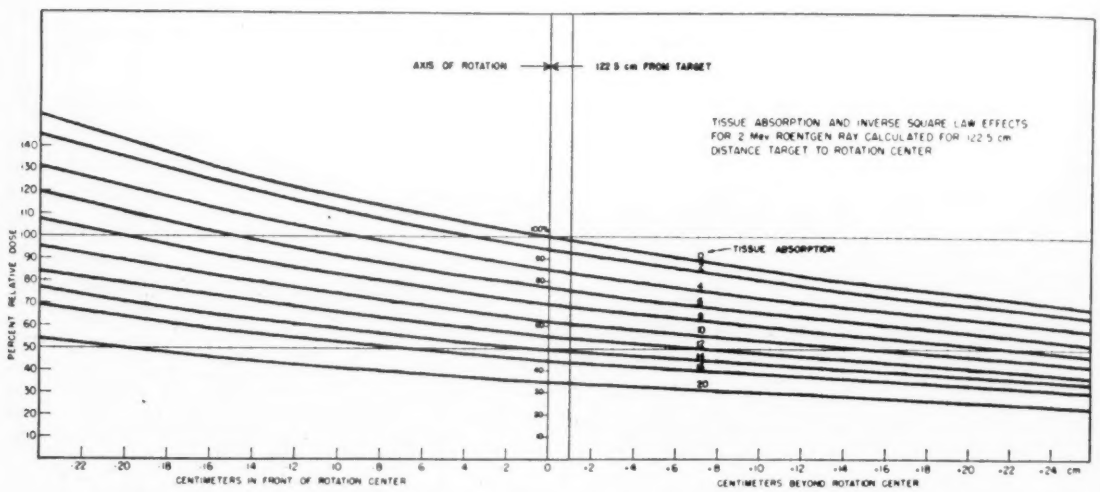
AXIS OF ROTATION
122.5 cm FROM TARGET
TISSUE ABSORPTION AND INVERSE SQUARE LAW EFFECTS FOR 2 Mev ROENTGEN RAY CALCULATED FOR 122.5 cm DISTANCE TARGET TO ROTATION CENTER
TISSUE ABSORPTION
PERCENT RELATIVE DOSE
CENTIMETERS IN FRONT OF ROTATION CENTER
CENTIMETERS BEYOND ROTATION CENTER

Fig. 3. Tissue absorption and inverse square law effects for 2 mev. roentgen rays calculated for 122.5 cm. distance target to rotation center.

In this case, the dose contributions from all other angles, not including P, must be counted as zero. Tissue of the lung cavities is considered as absorbing a quarter of the radiation compared to the normal tissue.

THE INSTRUMENT

To facilitate and increase the accuracy of measurements of intervening tissue depth and distance δ, a mechanical computing aid has been constructed as follows.

The beam from target T to point P (extended if necessary) and the line through C at right angle to the beam, intersect each other in point A. The line AP represents the distance of point P in front of or behind C. The geometrical locus of point A during rotation is a circle on CP as diam-

eter, center O, radius r (Fig. 4). The tissue depth is the distance PS.

$$\delta = 2r \cos \alpha = c \cos \alpha$$

$$c = \text{const.}$$

$$[\sqrt{(X_A - X_C)^2 + (Y_A - Y_C)^2}]^2$$

$$+ [\sqrt{(X_A - X_P)^2 + (Y_A - Y_P)^2}]^2 = c^2$$

$$X_P = \frac{c}{2}; \quad X_C = \frac{c}{2}; \quad Y_C = 0; \quad Y_P = 0$$

$$Y^2 + \left(X - \frac{c}{2}\right)^2 = \frac{c^2}{2} = r^2 .$$

These conditions enable an easy and rapid determination of tissue depth and relative target distance for any point P with a simple instrument.

Twenty-six concentric circles L at intervals of 0.5 cm. are engraved in a transparent lucite disk. They are the guiding circles for point A for distances of δ from 1 cm. to 24 cm. The circles are cut deep

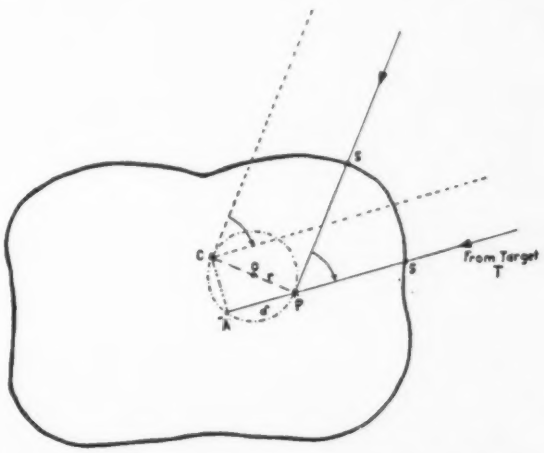

Fig. 4. Principle of the computer operation.

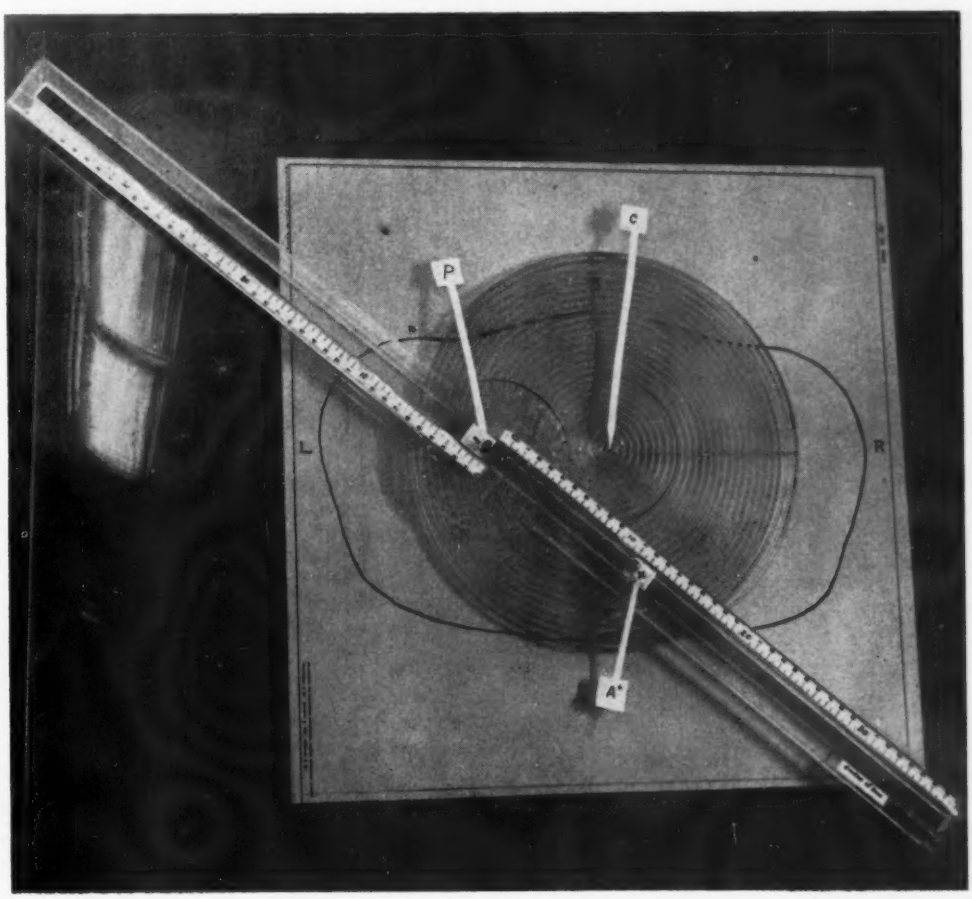

Fig. 5. Photograph of the computer.

enough for keeping the moving pointer A^- in the chosen circle (Fig. 5). At the same time as pointer A^- follows one of the circles it moves along a slider G, which rotates 180° around point P represented by pointer A^+. For this first rotation A^+ is fixed to the center of the slider in such a way that it can rotate, but cannot move in a longitudinal direction. As A rotates twice as fast as the beam circumscribing the body, the pointer A^- would be coincident with pointer A^+ after a rotation of 180°. To complete the second half of the beam rotation, the pointers A^- and A^+ must exchange roles. A^- coincides with P and A^+ now reads distance δ. The signs $-$ or $+$ indicate whether δ must be measured in Figure 4 in front of $(-)$ or behind $(+)$ C.

The slider is also built of lucite and carries 2 cm. scales, one for the reading of δ and the other for the determination of tissue depth and a protractor for measuring the angles. The outlines of the body section can be followed easily through the plastic slider and the tissue depth is determined by reading the centimeter scale from point P to the intersection S of this scale and the body outline.

Based on these principles a fully automatic computer, which electronically integrates the dose around a complete rotation, is under construction.

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The advice and encouragement of Dr. J. G. Trump and his associates is gratefully acknowledged. This work was financed from the funds of the American Cancer Society.

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EFFECT OF SOFT ROENTGEN RAYS ON THE RABBIT SKIN*

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CONSEQUENT upon the general availability of roentgen tubes having a low inherent filtration such as those with a beryllium window, there has been a revival of interest in so-called "soft" radiation. Whereas excellent studies of the physical characteristics of such beams have been published, there are no investigations dealing with effects of such irradiation on tissues.[5,10,11] The material presented below represents an effort to collect such information. Special consideration has been given to the relation between pathological damage and total roentgens delivered and an attempt has been made to correlate tissue depth dose and the localization of radiation damage.

MATERIALS AND METHODS

The roentgen-ray equipment used in this study was the currently available General Electric Maximar 100 unit (self-rectified, self-contained, oil-immersed, 60 cycle) equipped with a tube having a beryllium window measuring 3 mm. in thickness and 2.5 cm. in diameter. In all experimental studies, the machine was operated at 100 kv., 5 ma. and with no added filtration. Calibration in air was accomplished by using a 250 roentgen nylon chamber and the related equipment comprising the Victoreen condenser r meter. However, as is well known, the results obtained by such a technique are not accurate.[5,8] Trout, in comparing the results obtained with the standard air chamber and with the calibrated thimble chamber (such as we used) found that correction factors varying from 1.43 to 30 kv. unfiltered to 1.00 at 100 kv. with 3 mm. Al were required. Under the circumstances of this study, the correction factor is 1.28.[12] All the roentgen values expressed have been appropriately adjusted.‡

Albino rabbits were the only experimental animals used. They were maintained under the usual laboratory conditions.

In the usual experiment, a left paravertebral strip measuring 4 cm. in width and extending from the cervical region to the thigh was cleanly shaved. A period of forty-eight hours was allowed to elapse so that any irritation sequelae of the shaving could subside. The rabbit was then securely strapped on an animal board and irradiated. Six circular fields, each measuring 2.5 cm. in diameter, were exposed on each rabbit. Three of these were located within the shaved zone as follows: shoulder; mid-back and thigh. The three remaining fields were exact duplicates located on the unshaved side. For the data presented, the focal spot-skin distance was adjusted to 30 cm. The corrected output figure at 30 cm. was 1,390 roentgens per minute. Under these conditions, the experimental animals were irradiated with single doses of the following magnitude: 278; 695; 1,390; 2,780; 6,950 and 13,900 roentgens. One animal was used for each dosage level. During irradiation, the unexposed portion of the rabbit was protected by a lead shield measuring 3/16 of an inch in thickness.

Observations of any grossly visible changes in the skin were made at regular intervals. Biopsies, consisting of the complete thickness of epidermis and dermis down to skeletal muscle and extending from the center of the irradiated area to and through the unaffected margin were obtained from all shaved areas at 4, 8, 14, 28 and 75 days after irradiation except in the 278, 695, and 1,390 roentgen animals. Biopsies were discontinued in these animals after fourteen days because no gross evidence

‡ Since the paper was prepared, correction factors have been slightly changed. Personal communication from E. D. Trout, General Electric Co. X-ray Therapy Technical Letter No. 42).

* This work was done under United States Atomic Energy Commission Contract AT(30-1)-901 with the New England Deaconess Hospital.

† University of Utah School of Medicine, Department of Radiology, Salt Lake City, Utah.

of damage had become visible by this time. No biopsies were obtained from the unshaved areas. They were merely observed for evidence of epilation or other similar changes.

The biopsy specimens were fixed in Bouin's solution. After several washings in 70 per cent alcohol, they were stained with a variety of stains, including hematoxylin and eosin and phosphotungstic acid hematoxylin. Main reliance, however, was placed on Masson trichrome stains. In all, 200 slides were examined.

TABLE I

No. of Roentgens	24 Hours	4 Days	8 Days	16 Days	28 Days	75 Days
278	—	—	—	—	—	
695	—	—	—	—	—	
1,390	—	—	—	—	—	
2,780	—	—	—	1. Mild erythema 2. Light scaling 3. Slight induration 4. Mild epilation	1. Slightly atrophic 2. Mild scaling 3. Mild epilation	1. Normal skin 2. No epilation
6,950	1. Slight erythema	1. Slight erythema	—	1. Red-brown erythema 2. Leathery eschar 3. Complete epilation	1. White, atrophic area 2. Complete epilation 3. Some ulceration	1. White, atrophic skin 2. Slight regrowth of fine, white hair
13,900	1. Pink erythema	1. Erythema with induration and injection	1. Light tan area	1. Superficial firm, dark eschar	1. Hard, dark eschar surrounded by atrophic skin 2. Complete epilation	1. Pale, white atrophic area 2. No hair regrowth

EXPERIMENTAL RESULTS

The results obtained are summarized in Tables I and II, the first giving the gross observations and the second listing the microscopic changes. It should be emphasized at this point that the gross data represent a composite of the observations of six separate irradiated areas, all on a single animal. Likewise, the microscopic findings consist of a similar composite of the biopsies of three identically irradiated areas on the same animal. The differences in the observed effects on similarly treated areas were never of significance. The similarity of the findings, except in the rare instances where infection of the biopsy site occurred, was most striking.

It is apparent that, with dosage of 278, 695, and 1,390 roentgens, no gross changes had developed by the end of twenty-eight days. The animals were sacrificed at this point because it was felt that maximum response had already been achieved. Despite the absence of gross changes, however, minimal microscopic changes were detected. These were present at four days; faded thereafter. Changes appeared even with the lowest dosage, namely, 278 roentgens. These findings consisted of only an occasional swollen nucleus in the epidermal cells (Fig. 1 and 2).

With an exposure of 2,780 r, a mild erythema accompanied by slight induration and epilation appeared at approximately sixteen days. These effects faded slowly and at seventy-five days when the study was terminated, the skin and hair appeared grossly normal. However, the microscopic studies indicate permanent damage. Early irradiation changes seen in the cells of the epidermis and superficial portions of the dermis (Fig. 3) progressed to the development of an admixture of epidermal atrophy and hyperplasia by the end of seventy-six days. The superficial adnexae showed some loss and the collagen was slightly affected. The underlying striated muscle, panniculus carnosus, was undamaged (Fig. 4).

TABLE II

No. of Roentgens	4 Days	8 Days	14 Days	28 Days	75 Days
278	1. Occasional swollen epidermal cell nucleus (Fig. 1)	Negative	Negative		
695	1. Occasional swollen epidermal cell nucleus	Same	Negative		
1,390	1. Occasional swollen epidermal cell nucleus	Same	Same (Fig. 2)		
2,780	1. Swelling of nuclei of epidermis and adnexae 2. Edema and increased cells in dermal papillae	1. Same plus focal inflammation 2. Vascular congestion 3. Edema of entire dermis	1. Marked irregular swelling of nuclei of epidermis and adnexae 2. Edema of epidermis and dermis 3. Focal degeneration of collagen 4. Swelling of endothelium (Fig. 3)	1. Epidermal hyperplasia with some necrosis 2. Loss of adnexae and periadnexal fibrosis 3. Edema and fibrosis of dermis with loss of rete pegs 4. Swelling of fibroblasts	1. Epidermal hyperplasia and atrophy 2. Collagen deposit and degeneration 3. Some loss of adnexae 4. Muscle unaffected (Fig. 4)
5,950	1. Degeneration of epidermal and adnexal epithelium 2. Edema of superficial collagen with increased cells 3. Degeneration of rete pegs 4. Dilatation of vessels with swelling of endothelium (Fig. 5)	1. Irregular superficial necrosis 2. Degeneration of adnexae and collagen	1. Irregular necrosis of epidermis and adnexae 2. Pyknosis and shrinkage of fibroblasts 3. Muscle—variable damage	1. Hyperkeratosis and necrosis 2. Atrophy of adnexae and rete pegs 3. Fibrosis and degeneration of dermis 4. Vascular thickening 5. Moderate variable degeneration of muscle	1. Localized hyperkeratosis 2. Atrophy of rete pegs and adnexae 3. Fibrosis and degeneration of dermis 4. Some fibrosis of muscle (Fig. 6)
13,900	1. Necrosis and local liquefaction of epidermis 2. Increased cellularity in upper corium 3. Degeneration of adnexae 4. Swelling of endothelium	1. Early necrosis of skin and upper half of corium	1. Necrosis of skin and corium halfway down to muscle 2. Moderate degeneration of muscle (Fig. 7)	1. Irregular necrosis of epidermis and dermis	1. Atrophy of epidermis 2. Loss of rete pegs and adnexae 3. Fibrosis of corium with local degeneration of collagen 4. Irregular fibrosis of muscle (Fig. 8)

FIG. 1. *Above*, rabbit skin four days after 278 r. No morphologic changes of skin or subcutaneous tissue are observed. ×36. Insert, *below*, shows occasional swollen epithelial nuclei, found under higher magnification after comparable radiation and interval. ×500. Masson trichrome strain used for all tissues illustrated.

At 6,950 r, obvious damage was produced. Within twenty-four hours, a slight but definite erythema had appeared. This faded slowly and had completely disappeared by the end of eight days. At sixteen days, a secondary, somewhat browner, erythema had appeared. This was accompanied by definite induration and progressed to formation of a dark, leathery eschar which was unfixed to the underlying structures. The epidermis was never completely destroyed nor did it slough, and this area slowly developed into a white, atrophic scar in which there was a small amount of bizarre hair regrowth. The histological effects were marked. The epidermis later showed irregular microscopic areas of necrosis and all the adnexal cells appeared to be badly damaged (Fig. 5). There was degeneration of the superficial collagen segments of the dermis. The striated muscle fibers of the panniculus carnosus showed scattered areas of radiation damage. These effects were present at four days, the time of the initial biopsy and had reached their peak by the fourteenth day. By the end of seventy-five days, a good deal of regeneration had occurred but the epidermis was thickened, hyperkeratotic and contained bizarre cells. There was fibrosis and degeneration of the superficial collagen layers of the dermis. Similar degenerative changes were seen in the muscle but only sporadically and some intact areas remained (Fig. 6).

A similar but much more marked effect was produced with 13,900 roentgens. The initial erythema, present within twenty-four hours, was a striking pink. It never faded completely but changed to a light

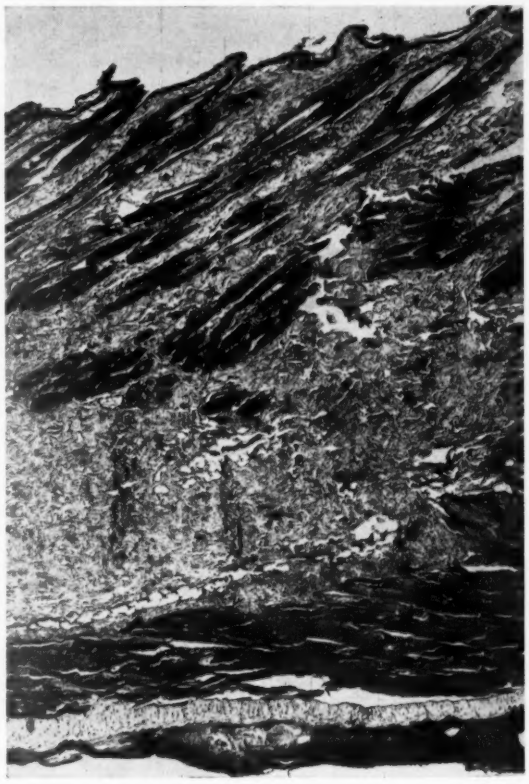

FIG. 2. After 1,390 r and interval of fourteen days, rabbit skin and subcutaneous tissues show no additional change. ×36.

tan at eight days, and then progressed to a dark brown, firm, superficial eschar at sixteen days. This gradually shrank in size and slowly deteached itself from the underlying skin. Complete separation had occurred by the end of seventy-five days. A zone of glistening, white, atrophic skin from which there was no visible hair regrowth was left. Microscopic examination showed what might be described as essentially complete necrosis of the epidermis and the upper half of the corium. Rete segments and adnexae were completely destroyed (Fig. 7). The underlying skeletal muscle showed scattered areas of radiation damage. By the end of seventy-five days, the zone of damage had been largely covered by a layer of atrophic epidermis. No rete segments or adnexae could be seen. The corium, especially in the upper levels, was fibrotic. There were areas of fibrotic replacement in the muscle layer, but many of the fibers showed no damage (Fig. 8).

Fig. 3. Fourteen days after 2,780 r, the epidermis and dermis are both edematous. Squamous cells and their nuclei are swollen and distorted, and basal cells are disoriented. Similar changes of gland cells are seen in the lower left corner. Vascular endothelium is swollen and collagen altered. ×500.

Fig. 4. Seventy-five days after 2,780 r, the epidermis demonstrates alternating areas of atrophy and hyperplasia. Some hair follicles and skin glands have disappeared. Collagen of the dermis is locally hyalinized and quantitatively increased. ×36.

DISCUSSION

The results of this study are of interest chiefly because of the superficiality of the lesions produced and the total number of roentgens required to produce specified effects. Insofar as can be determined, the cytological effects of the radiation used differ qualitatively in no way from those produced by more commonly employed roentgen radiation.[6,7,9,13,14] The quantitative effects and the depth distribution of the radiation damage are unusual, however. Both of these peculiarities are probably due to the fact that a 100 kv. roentgen-ray beam which has undergone essentially no inherent filtration was employed. The

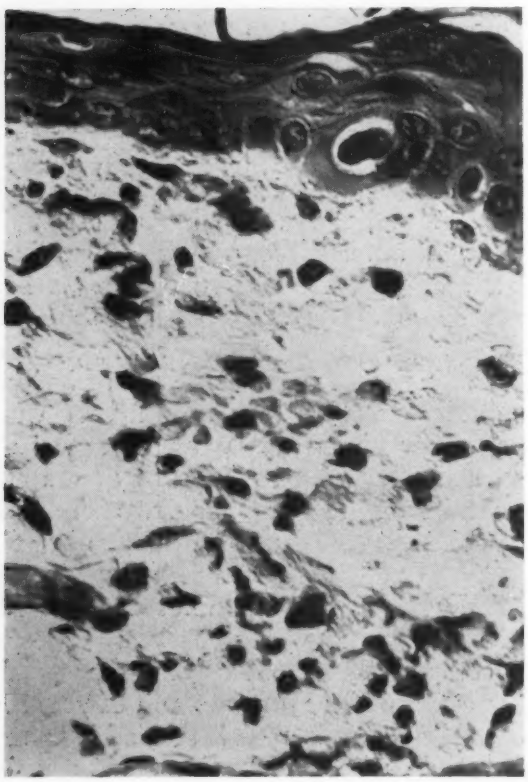

FIG. 5. Following 6,950 r and four days, the epidermal cells are irregularly swollen or pyknotic and the basal cells are disorganized. Rete pegs are gone. Edema of upper dermis is evident just beneath, and increased cells of fibroblastic and histiocytic types are seen. Lymphatic and blood vessel endothelium is swollen. ×500.

importance of inherent filtration is indicated by the fact that the unfiltered, 100 kv. roentgen-ray beam obtained from the usual glass tubes has a half-value layer of 1.0 mm. Al or thereabouts. The 100 kv. radiation of the beryllium window tube used in these studies has a half-value layer approximately 1/12 of that, namely, 0.08 mm. Al.[10,11] This difference is due solely to variation of inherent filtration. Although the 100 kv. radiation emanating from the beryllium window tube approaches the quality of grenz radiation, it is still not comparable. The half-value layer of 8 kv. grenz radiation is generally given as 0.036 mm. Al.[4,6] In Table III are listed certain physical data which will contribute some explanation for the variation in the effects of these three types of radiation.[3,4,6,11]

These figures indicate that 100 kv. beryllium window radiation would produce tissue effects intermediate between those induced by ordinary 100 kv. and grenz radiation. This is apparently the case. Milbradt has noted that at 13 kv. doses as large as 6,900 r are required to produce destructive changes in the cutis of rabbits. For the present study, 2,700 r produced some necrosis of the epidermis and moderate loss of

TABLE III

Radiation	Half-Value Layer mm. Al	Half-Value Layer-Tissue mm.
Grenz—8 kv.	0.036	0.35
100 kv.—beryllium window	0.08	0.7
100 kv.—usual tube	1.0	2.5

FIG. 6. Late changes, seventy-five days after 6,950 r, include atrophy of epidermis and adnexae, with localized hyperkeratoses. The dermis and upper muscle are replaced by dense partly hyalinized collagenous tissue. ×36.

the adnexae. At 6,900 r, there was definite necrosis of the epidermis and such marked destruction of adnexae that hair regrowth was slight. The effects extended deep enough to produce fibrosis of the dermis and some degeneration of the skeletal muscle. Very serious effects were apparent at a dosage of 13,900 r with necrosis of the epidermis and upper half of the corium and definite but not complete destruction of the underlying muscle. The 100 kv. radiation emitted by the ordinary glass filtered roentgen tube is known to cause much more serious damage in the deeper tissues at this dosage level. We are confronted, therefore, with a roentgen-ray beam of medium kilovoltage whose major effects are extremely superficial. Within the dosage range considered, radiation changes were almost entirely limited to the epidermis.

The maximum single dose delivered in these studies was 13,900 r. Under these circumstances, the major and most obvious effect was complete necrosis of the epidermis and the collagen immediately underlying it. However, at this dosage level, there was a sufficient amount of relatively hard radiation to produce radiation damage in deeper structures. The depth dose was of such magnitude as to cause permanent epilation and some fibrosis in the deep muscle layers of the cutis.

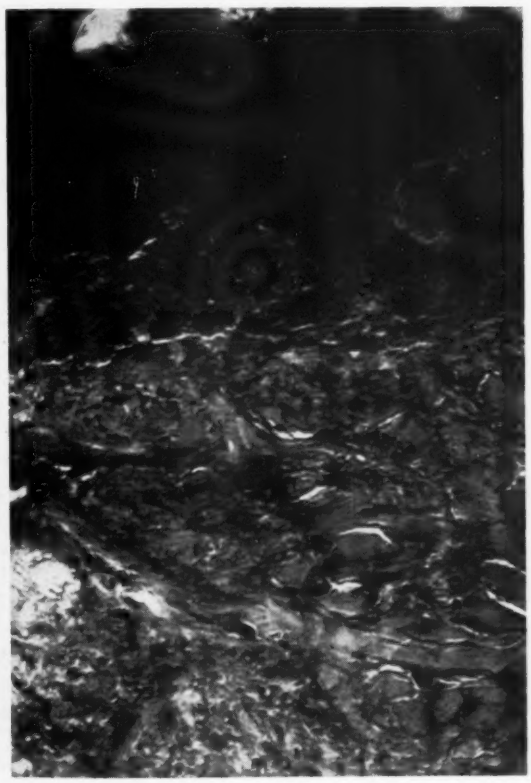

Fig. 7. Fourteen days following 13,900 r, the epidermis above is completely destroyed and a similar less extreme coagulation necrosis is observed in the dermis and its blood vessels; a vessel is shown at the left. ×500.

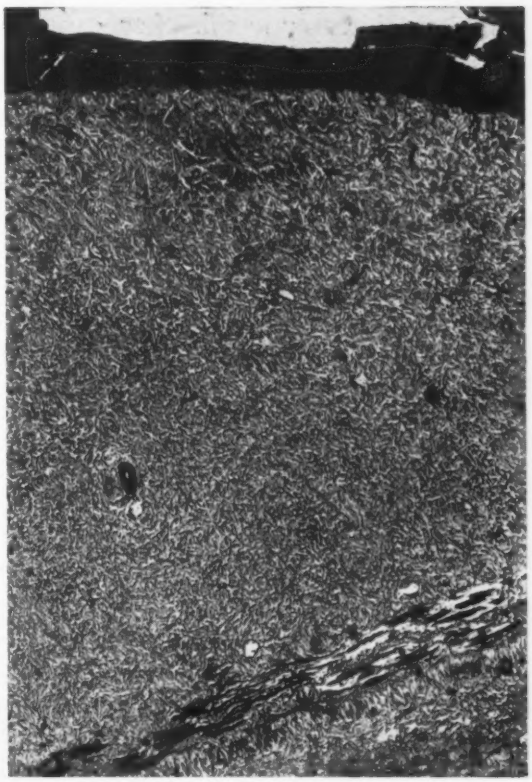

Fig. 8. Atrophy of epidermis, hair follicles and glands is complete seventy-five days after 13,900 r. No rete pegs remain. Overgrowth of dense collagenous tissue replaces the dermis and parts of underlying muscle. ×36.

In this respect, it is of interest to consider the tissue depth dose curve presented by Trout in relation to the total thickness of the rabbit's skin in order to indicate in a crude way how rapidly the depth dose falls off and how little of the total radiation was delivered to the muscle layer in comparison with the epidermis.[11] Obviously such a comparison is not rigid. The rabbits' skins

varied considerably in thickness, generally measuring 1.0 to 1.5 mm. down to the skeletal muscle layer. In addition, the depth dose in beef muscle is probably not comparable to that in rabbit skin. Realizing this, however, Trout's figures probably can be roughly applied. He found that under similar operating conditions the 0.5, 1.0, and 2.0 mm. depth doses were 56, 42 and 28 per cent respectively. The depth dose at the striated muscle level, therefore, was generally less than 50 per cent of that at the epidermis. This suggests why epidermal necrosis could be produced without severe damage to the striated muscle. Such considerations are obviously of great importance in determining the therapeutic applicability of such radiation.

None of the data presented is applicable or can be directly related to radiation changes occurring in human subjects. It has been stated that the rabbit skin has two and one-half times the tolerance of human skin. When allowance is made for this difference in sensitivity, the results roughly approximate those which would be expected in humans, namely, destruction of epidermis at 2,000 r and elimination of hair follicles at 1,600 r.[2] The only apparent paradox is in the amount required to produce erythema, which at grenz-ray levels is usually considered to lie between 200 and 300 roentgens.[4] In the present study, no erythema of the rabbit skin was detected until 2,700 r.

In summary, it might be stated that the unfiltered, 100 kv. beam emitted from a beryllium window roentgen tube produced cytological effects in the rabbit skin which were very superficial, at moderate dosage almost entirely limited to the epidermis. At very high dosage, 7,000 to 14,000 r delivered in a single sitting, there were definite and permanent pathological effects apparent at deeper levels. These extended as far as the muscular layer of the cutis. At those dosage levels, however, the overlying epidermis has been very seriously affected. This essentially is what one would expect on the basis of physical studies reported by Trout and Gager.

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Vol. 68, No. 5

DETECTION OF FAULTY ROENTGENOSCOPIC TECHNIQUE BY DIRECT RADIATION MEASUREMENTS

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THERE have been many studies reported in the radiological literature in which accurate measurements of scattered radiation have been made around the roentgenoscopic table.[1–8] These studies have usually been made by an indirect method using phantoms and are difficult to translate into the quantity of radiation received by the exposed portions of the roentgenoscopist's body.‡ Radiologists are well aware of the effect of the size of the shutter opening and actual roentgenoscopic time on the quantity of scattered radiation received during roentgenoscopy. However, little attention is given to the influence of other factors of technique such as manner of palpation, positions of the patient and examiner, presence of observers in the room, etc., on the amounts of radiation received by the examiner.

The present study was undertaken to measure the average dosage received by each of several exposed portions of the roentgenoscopist's body during upper gastrointestinal examinations and barium enema examinations. It was felt that such a study would impress upon the minds of the residents the importance of developing good technique. While the primary purpose of the study was to demonstrate the quantity of radiation received, it soon became apparent that this survey was actually revealing each individual's faults in his manner of using the roentgenoscope.

APPARATUS

All studies were carried out with one roentgenoscopic unit. This was a motor driven table that was closed on both sides and bottom with approved shielding (Picker Standard 200 Series Table). A spot film device was used for the upper gastrointestinal examinations. This was removed for the barium enema studies and the larger fluorescent screen was substituted in its place. The technical factors employed were: 4 ma. for roentgenoscopy with spot films taken at 100 ma. The average patient was roentgenoscoped at 75 kv., but this factor was altered up to 85 kv. for heavy patients.

Pocket dosimeters were used for the study. The manufacturer* reports the calibration error of these dosimeters as being less than 3 per cent of the scale reading at any point on the scale up to 100 milliroentgens, and 5 per cent up to 200 mr. Each dosimeter is so constructed that it is energy independent within 10 per cent down to a roentgen-ray cut off region, *i.e.*, approximately 25 kilo electron volts, except for a peak of plus 20 per cent at 70 kv. This latter phenomenon is present in all commercially available dosimeters and is the result of a maximum photoelectric effect which occurs in this region of energies. The pocket dosimeters were fastened to the roentgenoscopist's clothing in the selected positions by means of adhesive tape.

At the beginning of each roentgenoscopic period, the dosimeters were charged until the fiber image was brought to zero. They were then fastened to the roentgenoscopist in selected positions, as illustrated in Figure 1. At the end of the first examination, a direct reading was taken since the fiber

‡ Since acceptance of this paper for publication, another excellent similar paper has been published by Jacobson *et al.*, *Radiology*, April, 1952, *58*, 568–582.

* The authors are indebted to the Keleket X-Ray Corporation for supplying six dosimeters without which this study could not have been performed.

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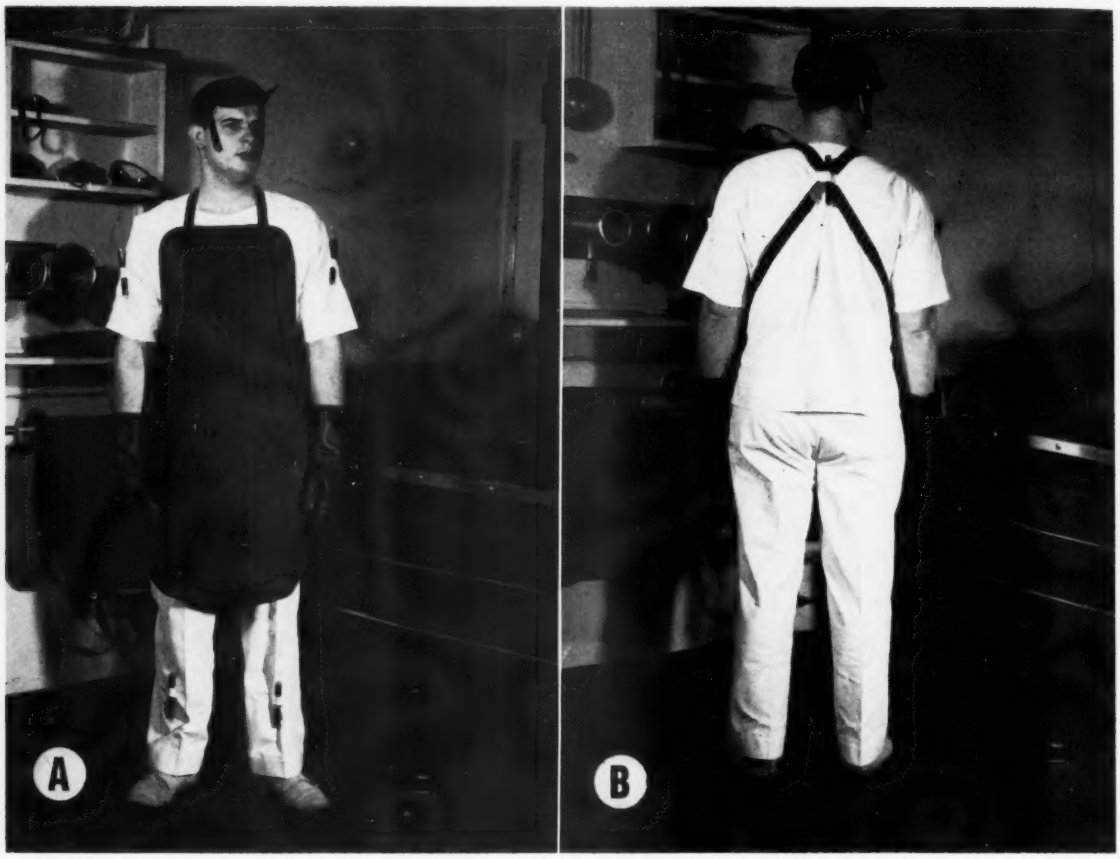

FIG. 1. Attire worn by the roentgenoscopists during this study. Note location of dosimeters on the head, upper arms, back and lower legs.

image was at zero at the beginning of this examination. The readings for the following examinations were obtained by subtracting the reading at the beginning of each examination from the reading at the end of the examination. At the end of each examination, the positions of the dosimeters, the amount of radiation measured by each dosimeter, and the actual time of roentgenoscopy, as measured by an intermittent timer in the roentgenoscopic electric circuit, were recorded on a special sheet of anatomic diagrams (Fig. 2). An individual sheet was used for each roentgenoscopic examination. Any important comments offered by the examiner were annotated on the record sheet.

PRELIMINARY STUDY

A preliminary survey was made on 19 cases. The dosimeters attached to various parts of the roentgenoscopist's body showed that the exposed portions of the forearms, the upper arms and the legs were receiving the greatest amount of radiation. The head and back received negligible amounts in comparison to the arms and legs. Because of this preliminary survey, it was decided that the arms and legs should be monitored most frequently with the dosimeters and the other parts of the body would be surveyed intermittently during the study. After the first week's monitoring, the results were studied. The participants agreed not to voluntarily attempt to change their techniques until the study was completed.

FINAL STUDY

One hundred and five roentgenoscopic examinations were performed. Eighty-seven of these were upper gastrointestinal

and colon examinations. Only those data obtained from these 87 cases are reported in the present paper.

The roentgenoscopic examinations were carried out by each of the three residents and a radiologist respectively. The residents are henceforth designated A, B and C.

Resident A was the most experienced of the three trainees, since he was completing his third year of residency. The other two residents had similar educational backgrounds but had only nine months of roentgenoscopic experience. The radiologist had been certified by the American Board of Radiology and had had seven years of experience.

A summary of the average amounts of scattered radiation measured at the various points described above is presented in Tables I and II.

Resident A, as recorded on Table I, averaged five minutes and forty seconds of *continuous* roentgenoscopic time for each upper gastrointestinal series roentgenoscoped. He received an average of 3 mr. per examination to the right upper arm,

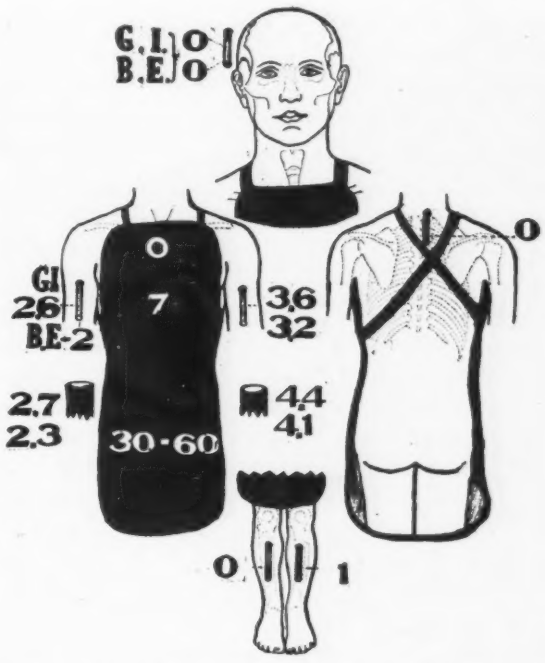

Fig. 2. Illustration of anatomic diagram sheet used to record the radiation received by each dosimeter after each roentgenoscopy. Figures indicate average amount of radiation in milliroentgens received by radiologist during gastrointestinal and barium enema studies.

Table I

AVERAGE DOSAGES RECEIVED BY RESIDENTS AND RADIOLOGIST DURING UPPER GASTROINTESTINAL EXAMINATION

	Right Arm (mr.)	Left Arm (mr.)	Right Leg (mr.)	Left Leg (mr.)	Right Fore-arm (mr.)	Left Fore-arm (mr.)	Average Time
Resident A	3.0	3.3	3	1.3	4.0	7.2	5′40″
Resident B	3.4	3.8	4	—	2.3	5.6	5′15″
Resident C	5.8	8.1	—	—	7.2	9.0	3′19″
Radiologist	2.6	3.6	0	0.75	2.7	4.4	3′39″

It is seen that even if one accepts the maximum readings of 9 mr. per case to the exposed portions of the arms and 4 mr. to the lower legs, one may still safely roentgenoscope up to 33 gastrointestinal cases per week, if 300 mr. per week is considered the safe tolerance dosage. Actually this tolerance dose of 300 mr. per week applies to total body radiation and not just to isolated portions of the body, in which event 1.5 r per week has been thought to be "safe."

Table II

AVERAGE DOSAGES RECEIVED BY RESIDENTS AND RADIOLOGIST DURING BARIUM ENEMA EXAMINATION

	Right Arm (mr.)	Left Arm (mr.)	Right Fore-arm (mr.)	Left Fore-arm (mr.)	Right Leg (mr.)	Left Leg (mr.)	Average Time
Resident A	2	1.2	—	—	0	0	2′53″
Resident B	3.4	3.5	3.4	6.5	—	—	4′05″
Resident C	3.5	2.9	14.0	4.7	0	.66	2′02″
Radiologist	2.0	3.2	2.3	4.1	0	0	2′31″

3.3 mr. to the left upper arm, 4 mr. to the right forearm and 7.2 mr., or 80 per cent more, to the left forearm. This significant difference between the amounts received by the right and left forearms resulted from palpating with the left hand. In so doing, the left forearm was exposed. Without voluntarily trying to change his technique the roentgenoscopist caused a reversal in the amounts of radiation received by each upper arm after he learned of the higher reading on the left arm. He admitted that involuntarily he had probably used more caution in palpation and was using his opposite hand more for this part of the work. One other factor of interest in Resident A's measurements was the difference in radiation received on the left and right leg. The average reading on the right leg was over twice the average reading of the meter on the left leg. The reason for this difference was not obvious at first. Later it was noted that Resident A continuously extended his right leg under the fluorescent screen and operated the foot switch in that position whenever the table was in the upright position. This error in technique and the resulting unnecessary exposure was remedied by simply placing the foot switch near the operator's seat behind the lead apron attached to the seat.

Resident B had average readings closely paralleling those of Resident A. It was observed that his technique was very similar to that of Resident A. The same corrections subsequently had to be made in his technique.

Resident C required less continuous roentgenoscopic time than either of the other residents. In spite of this, he received more radiation to his arms. This does not belittle the time factor but rather stresses the importance of the size of the shutter opening and other factors of technique. The reason for his comparatively high readings were observed to be excessive palpation, standing to one side or the other of the fluorescent screen and the maintenance of an excessively wide shutter opening. All of these technical errors were noted on the diagram sheets by Resident C at various times during the survey.

The radiologist's measurements averaged less than the residents'. His average time was greater than Resident C but less than either of the other two residents. His readings have one thing in common with those of the residents—the left arm and forearm received more radiation than the right. This difference was not due to the fact that the radiologist palpated with his left hand because he used only his right hand for this. It was the result of standing to the left of the screen so that observers in the room could better visualize the screen. When he became aware of the higher readings of his left arm, even though he made no voluntary attempts to alter his technique, subsequent readings showed that he subconsciously protected the left arm and exposed the right arm more often.

Table II demonstrates the average quantity of radiation received during barium enema examinations. The significant finding here is that the average quantity received by the upper arms is not reduced proportionately to the time. For example, Resident B had very similar readings on the meters on the upper arm on both barium enema examination and upper gastrointestinal examination, despite the fact that his time of continuous roentgenoscopy averaged over a minute less for each barium enema examination. This fact also holds true for the radiologist. One of the reasons for the apparent increased dosage in relation to time during the barium enema examinations may be found in the fact that no spot film device was in place for these examinations; therefore, the shutter aperture could be opened to its limits and thus encouraged larger beam sizes. In addition to this, the patient was roentgenoscoped in the horizontal position during the entire examination. This permitted considerable scattered radiation from the table top and radiation through the Bucky slot to strike the examiner. The roentgenoscopist avoided this exposure during half of the upper gastro-

intestinal examinations because the patient was roentgenoscoped in the erect position during the first part of each gastrointestinal study.

Some of the averages of other monitored areas are of interest. The head received no significant amount of radiation during most of the examinations. The shoulder areas received practically no radiation. The legs below the level of the apron were exposed significantly only during erect roentgenoscopy. The back between the scapulae received no measurable radiation except when an exposure was carelessly made by a technician as the examiner turned his back to the table to leave the room. Dosimeters placed on the body underneath the apron gave no readings, thus showing no measurable amounts of radiation under the apron. A meter placed on the outside of the apron at the level of the Bucky slot—the level of the genitalia of the man of average height—measured as high as 60 mr. outside of the apron at this level, but averaged 30 mr. per case.

Some of the comments made after various examinations are interesting and of significance. On one record sheet there appears the notation "Spectator present, wanting to see things." The readings for this examination were: 12 mr. to the right arm, 10 mr. to the left arm, 10 mr. to the right forearm, 13 mr. to the left forearm. These readings are far above the average for any of the roentgenoscopists. All records showed that the presence of a spectator created a definite hazard to the roentgenoscopist. In all cases the amounts of radiation received on each dosimeter were greatly increased.

In one case Resident C received 2 mr. to the right arm but the left arm received approximately 24 mr. On the recording sheet is the statment, "Standing to the left of the screen."

Other factors were also found to influence the exposure. One resident attempted to hold a patient with the left arm while roentgenoscoping the chest. The reading on the supporting arm was many times above the average.

Tall patients caused an increase in the amount of radiation received by the head of the roentgenoscopist. When these patients were roentgenoscoped in the erect position with the radiologist seated on a standard roentgenoscopic chair, radiation scattered below the screen and the head of the examiner received measurable quantities of radiation as shown by readings on dosimeters attached by the examiner's ear.

COMMENT

This paper is not meant to be a report of actual measurements applicable to every roentgenoscopist but it is presented as a description of a type of monitoring survey technique. It would be of value if such a survey were carried out by every man in training. Errors in technique which may otherwise be imperceptible are demonstrated and create a lasting impression on the roentgenoscopist. It is needless to say that this type of direct measurement technique survey may benefit older radiologists as well.

CONCLUSIONS

A monitoring of various parts of the roentgenoscopist's body, using direct measuring instruments revealed the following facts:

1. The experienced radiologist with refined technique receives less radiation than the inexperienced radiologist. This fact is not dependent on the time factor.
2. The time factor is an important factor only when other things are equal.
3. "Handedness" of the roentgenoscopist influences the amount of radiation received to the upper arms. The upper arm of the palpating hand will receive more radiation than the upper arm of the nonpalpating hand.
4. The location of the foot switch during roentgenoscopy in the vertical position is a significant factor in determining the quantity of radiation received by the legs.
5. Large fluorescent screens encourage large beam sizes and increase dosage to the arms of the roentgenoscopist.

6. The roentgenoscopist receives more radiation when standing to one or the other side of the fluorescent screen. Roentgenoscopic screens bearing lead rubber drape attachments eliminate considerable secondary scatter.

7. Spectators cause an increase in the amount of radiation received by the roentgenoscopist by: (a) causing the demonstrator to stand to one side or the other of the screen; (b) increasing the time of roentgenoscopy by their "wanting to see" the roentgenoscopic image.

8. Attempting to support patients during roentgenoscopy causes the roentgenoscopist to receive large quantities of scattered radiation.

9. Roentgenoscopic examination of tall patients in the erect position without proper adjustment of the operator's seat and fluorescent screen lead drapes to compensate for the patient's height will cause unnecessary exposure of the operator's head.

10. A roentgenoscopist who knows his errors in technique will subconsciously react to protect himself, even though he is not aware of taking protective actions.

11. Measurements obtained in the above study under the described conditions would indicate that not over thirty-three gastrointestinal and colon roentgenoscopic examinations should be performed weekly if the roentgenoscopist is to be well within the limit of 0.3 roentgen per week* to his arms. Actually, since the figure of 300 milliroentgens per week (0.3 r) of radiation applies to total body radiation, many more roentgenoscopies could be performed and the examiner would still be well within this figure provided he wore an apron and gloves.

* Nothing in this paper is meant to imply that the authors accept or reject the fact that 0.3 roentgen per week total body radiation is a "safe" tolerance limit.

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Vol. 68, No. 5

THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

Editor: Lawrence Reynolds, M.D. *Assistant Editor:* Ruth Bigelow, B.S.

Associate Editors: Harry Hauser, M.D., Traian Leucutia, M.D., Russell H. Morgan, M.D., Edward B. D. Neuhauser, M.D., Wendell G. Scott, M.D.

Consulting Editorial Board: See front cover.

Published by: Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Illinois.

Issued monthly. Annual subscription: United States, Mexico, Cuba, Central and South America, $15.00; Canada, $16.00; other countries, $17.00. Current single numbers, $1.50. Advertising rates submitted on application. Editorial office, 110 Professional Building, Detroit 1, Michigan. Office of publication, 301–327 East Lawrence Avenue, Springfield, Illinois. Information of interest to authors and readers will be found on page iv.

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Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Fifty-fourth Annual Meeting: 1953, to be announced.

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Representatives on National Committee for Radiation Protection: Edith H. Quimby, New York, N. Y., John E. Wirth, Pasadena, Calif.

Thirty-fifth Annual Meeting: Chase Hotel, St. Louis, Mo., April 19, 20, 21 and 22, 1953.

EDITORIAL

THE FIFTY-THIRD ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Fifty-third Annual Meeting of the American Roentgen Ray Society, which was held at the Shamrock Hotel, Houston, Texas, from September 23 to 26, 1952, was a splendid success from every point of view. This was the first time that the American Roentgen Ray Society had held a meeting in Texas and that Houston was a happy choice was borne out in all the varied aspects of the meeting, from its satisfactory registration to the large attendance at the scientific sessions and the many excellent scientific and commercial exhibits.

From Dr. Charles L. Martin's preliminary program it was evident that the meeting would be very much worth while from a scientific point of view, and the completed program as presented at the meeting confirmed the anticipated opinions. Dr. Martin's program was a well balanced one comprising diagnostic and therapeutic papers as well as those dealing with experimental aspects of radiology and medicine, and the program was so arranged that at each session there was a diversity of papers, some, if not all, of which would interest all radiologists. The papers will, as usual, be published in future issues of the JOURNAL.

A most cordial welcome to the State of Texas was extended by Dr. Chauncey D. Leake, Vice-President, Medical Branch, University of Texas, Galveston. He made an extremely interesting and stimulating address, as would be expected, and when he finished everyone felt that the Houston meeting would be an exceptional one, its members and guests having been welcomed by so outstanding a person as Dr. Leake.

On Tuesday evening the annual Caldwell Lecture was given by Dr. Edward B. D. Neuhauser, Assistant Professor of Radiology, Harvard Medical School, and Radiologist-in-Chief, The Infants' and the Children's Hospitals, Boston, Massachusetts, who had chosen as his topic "Growth, Differentiation, and Disease." No one is better qualified to undertake such a discussion than Dr. Neuhauser. His profound interest in the diseases of infants and children would qualify him no less than the broader aspects of his medical knowledge and clinical training. At the conclusion of the lecture President Martin awarded to Dr. Neuhauser the Gold Medal of the Society. Then graciously stepping out of his presidential role, Dr. Martin, as a distinguished Texan, bestowed upon the lecturer a ten gallon hat and an artistically studded cowboy belt, the insignia of a good Texan.

The Instruction Courses, which were so ably arranged by Dr. Harry M. Weber and conducted by the outstanding faculty which he had selected, proved, as is usual at the annual meetings, to be of great interest and benefit to those who were fortunate in securing admission to the various courses.

The Scientific Exhibit Committee had arranged a magnificent Scientific Exhibit, among the best and largest that the Society has ever had, and the space which was available for these exhibits could not be surpassed and rarely equaled. Some of the scientific exhibits amplified the papers which were given in the scientific sessions. To those who participated in the Scientific Exhibit nothing but grateful thanks should be given because the amount of labor entailed is at times scarcely appreciated by those who casually inspect the exhibits. Perhaps

as much real knowledge can be obtained from a well organized exhibit when properly presented and discussed by the exhibitors as can be had from any paper presented in the scientific sessions; and certainly the group of scientific exhibits which were arranged for the Houston meeting bore the stamp of excellence in all respects.

Grouped in the same hall with the scientific exhibits were the Commercial Exhibits, and certainly at no other meeting of the Society have the manufacturers displayed equipment which provided greater interest than was seen at Houston. Those attending the meeting who failed to avail themselves of a careful survey of the commercial exhibits lost a splendid opportunity.

The social aspects of the meeting were all that one could desire in the great State of Texas, which is known for its unexcelled hospitality. On Monday was held the Annual Golf Tournament at the beautiful River Oaks Country Club. This Club is a fine expression of the many splendid things which dynamic Houston may boast of. Members competed for the Willis F. Manges Trophy and members and guests for the Exhibitors Trophy. The tournament was followed by the Annual Golf Dinner at the Club. Thursday evening was set aside for the Annual Banquet of the Society, and Dr. Martin and his Local Committee had arranged a most unusual program of entertainment. At the banquet, which was preceded by cocktails, Dr. Martin made the presentation of scientific exhibit awards. This was a continuation of a recently instituted procedure which is an excellent one. The names of the exhibitors who were fortunate in receiving the awards are given elsewhere in this issue of the JOURNAL, in the description of the scientific exhibits. The Local Ladies Committee had arranged a number of social events for the visiting ladies, which was another of the pleasant features of the meeting.

To Dr. Palmer E. Wigby, Chairman of the Local Committee, and to Mrs. Wigby, the Chairman of the Ladies Committee, and to all of those who participated in the excellent local arrangements for the meeting the Society desires to express its thanks.

The Shamrock Hotel is admirably suited for the holding of conventions. The beauty of the hotel itself and the very competent and friendly personnel with which the hotel has surrounded itself bespeak the best in hotel accommodations and care. To the hotel management and its staff of employees, the American Roentgen Ray Society desires to express its deep appreciation for the splendid services in the very beautiful and elegant surroundings in which their 1952 annual meeting was held.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: 1953, to be announced.

AMERICAN RADIUM SOCIETY
Secretary, Dr. J. E. Wirth, 635 Herkimer St., Pasadena 1, Calif. Annual meeting: Chase Hotel, St. Louis, Mo., April 19–22, 1953.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Netherland-Plaza Hotel, Cincinnati, Ohio, December 7 to 12, 1952.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting: 1953, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

ARIZONA RADIOLOGICAL SOCIETY
Secretary, Dr. R. Lee Foster, 15 E. Monroe, Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Elbert K. Lewis, 6337 S. Harvard Ave., Chicago, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. W. P. Stampfli, 1933 Pearl St., Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. J. C. Cook, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. A. Judson Graves, 2002 Park St., Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

GREATER MIAMI RADIOLOGICAL SOCIETY
Secretary, Dr. Maurice Greenfield, Ingraham Bldg., Miami, Fla. Meets third Wednesday of each month at Veterans Administration Building.

HOUSTON RADIOLOGICAL SOCIETY
Secretary, Dr. F. M. Windrow, 1205 Hermann Professional Bldg., Houston, Texas. Meets fourth Monday each month.

IDAHO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. James McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Willis L. Beeler, M.D., 700 Kansas Ave., Topeka, Kansas. Meets in spring with State Medical Society, and in winter on call.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

KINGS COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430 48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. John B. Hamilton, 210 N. Central Ave., Glendale 3, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MAINE RADIOLOGICAL SOCIETY
Secretary, Dr. C. F. Miller, Central Maine General Hospital, Lewiston, Maine.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. L. A. Nash, 572 Lowry Medical Arts Bldg., St. Paul 2, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 621 High Street, Jackson 2, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Nassau Radiological Society
Secretary, Dr. Joseph J. La Vine, 259 North Grand Ave., Baldwin, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. R. W. Blanchard, 1216 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 P.M. at Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Harold W. Jacox, 622 W. 168th St., New York 32, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. John F. Roach, Albany Hospital, Albany, N. Y. Meets on the second Wednesday of October, November and March at the University Club, Albany. Annual meeting in June to be announced.

Northern California Radiological Club
Secretary, Dr. G. A. Fricker, Sacramento County Hospital, Sacramento, Calif. Meets at dinner last Monday, every second month, except June, July and August.

Ohio State Radiological Society
Secretary, Dr. Willis S. Peck, 2001 Collingwood Blvd., Toledo, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. George P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets 6:00 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. U. V. Wilcox, 915 Nineteenth St., N. W., Washington 6, D. C. Meets Medical Society Library, third Thursday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Harry K. Hines, 2508 Auburn Ave., Cincinnati 19, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Colonel Alexander O. Haff, M.C., Tripler Army Hospital, Honolulu, T. H. Meets third Friday of each month at Tripler Army Hospital.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of New Jersey
Secretary, Dr. Nicholas G. Demy, 912 Prospect Avenue, Plainfield, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Robert J. Bloor, 260 Crittenden Blvd., Rochester, N. Y. Meets last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Next annual meeting, Shirley-Savoy Hotel, Denver, Colo., August 20, 21 and 22, 1953.

St. Louis Society of Radiologists
Secretary, Dr. Francis O. Trotter, Jr., 634 N. Grand Blvd., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. Rex Uncapher, 7720 Girard Ave., La Jolla, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology, California Medical Association
Secretary, Dr. Calvin L. Stewart, 2330 First Ave., San Diego 1, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH BAY RADIOLOGICAL SOCIETY
Secretary, Dr. Ford Shepherd, 526 Soquel Avenue, Santa Cruz, Calif. Meets second Wednesday each month.

SOUTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. Henry E. Plenge, Spartanburg General Hospital, Spartanburg, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting: San Antonio, Texas, January 23 and 24, 1953.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

UTAH STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1, Wash. Meets fourth Monday of each month from September through May.

WESTCHESTER RADIOLOGICAL SOCIETY
Secretary, Dr. Walter J. Brown, Northern Westchester Hospital, Mt. Kisco, N. Y. Meets on third Tuesdays of January and October and on two other dates.

WISCONSIN RADIOLOGICAL SOCIETY
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. Charles E. Duisenberg, Palo Alto Clinic, 300 Homer Ave., Palo Alto, Calif. Meets third Thursday at 7:45 P.M., January to June, Lane Hall, Stanford University Hospital; July to December, San Francisco Hospital.

CUBA, MEXICO AND CENTRAL AMERICA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

SOCIEDAD RADIOLÓGICA PANAMEÑA
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1. Annual Meeting, London, England, December 4 and 5, 1952.

FACULTY OF RADIOLOGISTS
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

COLLEGE OF RADIOLOGISTS (AUSTRALIA AND NEW ZEALAND)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

SOUTH AMERICA

ASOCIACION ARGENTINA DE RADIOLOGIA
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, JUNTA CENTRAL, BUENOS AIRES
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL LITORAL, SEDE, ROSARIO
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL SUR, SEDE, LA PLATA
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL CENTRO, SEDE, CORDOBA
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL NORTE, SEDE, TUCUMAN
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DE CUYO SEDE, MENDOZA.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD COLOMBIANA DE RADIOLOGIA
Secretary, Dr. Alberto Torres Focke, Av. 34, No. 17-34, Bogota, Colombia. Meets last Wednesday of each month.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

SOCIÉTÉ FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE, and its branches: SOCIÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET DU LYONNAIS, DE

L'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^e^, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Roentgen-Gesellschaft
Secretary, Dr. Peter Kröker, (22a) Essen-Helsingen, Westpreussenstrasse 21. Meets annually in different towns.

Societa Italiana dr Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

SCIENTIFIC EXHIBIT

The Scientific Exhibit at the Fifty-third Annual Meeting of the American Roentgen Ray Society held at the Shamrock Hotel, September 23 to 26, 1952, which was arranged by the Committee on Scientific Exhibits under the chairmanship of Dr. E. B. D. Neuhauser, was an excellent one in all respects and one of the largest that the Society has ever had. Under the stimulus of Dr. Neuhauser there appeared to be great interest in the Scientific Exhibit as shown not only in the number but in the quality of the exhibits. The space occupied by the Scientific Exhibit was closely adjacent to the Commercial Exhibit. An idea of the scope and extent of the exhibits may be had from the following brief descriptions of each exhibit together with the awards which were made.

Roentgen Demonstration of Parathyroid Adenoma. Stanley M. Wyman, M.D., and Laurence L. Robbins, M.D., Massachusetts General Hospital, Boston, Massachusetts. This excellent exhibit consisted of roentgenograms of selected cases demonstrating the typical roentgen appearance of parathyroid adenoma and the technique used for its localization. The authors stated that between 1943 and April, 1952, approximately 50 parathyroid adenomas were removed surgically at the Massachusetts General Hospital. The roentgenograms in 34 cases were available and satisfactory. In 20 of these the site of the adenoma could be verified on the films. In order to localize parathyroid adenoma, the roentgen technique requires a combination of roentgenograms, both plain and overpenetrated, roentgenoscopy and spot films with and without barium. It is not likely that a parathyroid adenoma of less then 1.5 to 2 cm. in diameter will be recognized unless it is most strategically placed.

The authors arrived at the following conclusions: (1) The location of the parathyroid adenoma is demonstrated roentgenographically by changes from the normal detectable in the trachea and esophagus. These structures are displaced and indented by the tumor mass. (2) Recognition of parathyroid adenoma may be of value in making a diagnosis of hyperparathyroidism. (3) Preoperative demonstration of the parathyroid adenoma is important as a guide to surgical approach. This exhibit received the highest award given this year by the Society, the Silver Medal.

Roentgenographic Techniques for Use in Radiotherapy. Robert J. Bloor, M.D., Lillian M. Fuller, M.D., and Dante DeLella, University of Rochester School of Medicine and Strong Memorial Hospital, Rochester, New York. This excellent exhibit was presented with a view of demonstrating techniques for the making of roentgenograms showing accurate direction of the beam and verification of the portal position when employing conventional 200 kv. therapy. Graphs were shown expressing the exposure time in seconds per 1 r per minute for various patient thicknesses when using cardboard holders (screen film) and calcium tungstate screens (screen film—Lysholm grid). The value of this method in routine radiation therapy was demonstrated by typical roentgenograms.

The following is one example of how the method works: A patient with bronchogenic carcinoma measures 20 cm. across the chest. This particular machine delivers an r output of 10 per minute at 100 kv., 50 focus skin distance. A field area of 150 sq. cm. is desired for treatments. According to the graph, for a radiation rate of 1 r per minute, 100 second exposure would be necessary. Since 10 r per minute is used, the desired exposure is 1/10 of this, or 10 seconds. This exhibit was awarded the Bronze Medal. Four Certificates of Merit were given.

A Certificate of Merit was awarded to the exhibit entitled *Pulmonary Stenosis with Intact Ventricular Septum* by Melvin M. Figley, M.D., Aaron M. Stern, M.D., Herbert E. Sloan, Jr., M.D., and Walter M. Whitehouse, M.D., University Hospital, Ann Arbor, Michigan. In this exhibit a series of cases of pulmonic stenosis with intact ventricular septum collected over the past five years was presented. Roentgenograms, angiocardiograms, cardaic catheterization data and photographs of autopsy material were shown to correlate the anatomic and physiologic abnormalities. Experience with this material has allowed accurate recognition of this form of congenital heart disease by simple roentgenologic methods.

Another exhibit receiving a Certificate of Merit was *Carcinoma of the Prostate* by Rubin H. Flocks, M.D., H. B. Elkins, M.D., H. Dabney Kerr, M.D., and David A. Culp, M.D., College of Medicine, State University of Iowa,

Iowa City, Iowa. This exhibit depicted the experience of the authors in treating a series of cases of carcinoma of the prostate with the most efficient method, depending on the stage of the carcinoma. The carcinoma was divided into three clinical stages and the following method was used in each respective stage: Stage I. The carcinoma is limited to the prostate without periprostatic involvement—treated by total prostatectomy; Stage II. The carcinoma has already passed the confines of the prostatic capsule comprising roughly 30 per cent of all the cases seen by the authors—treated by instillation of radioactive gold; Stage III. The carcinoma has already spread to distant parts, usually to the bone, comprising 45 per cent of the series—treated by hormones, orchiectomy and repeated transurethral resections.

This exhibit consisted of three panels, each panel illustrating in detail the procedure for the respective three stages and was accompanied by mimeographed copies giving at length the details of the use of the radioactive colloidal gold, such as the method, dose, protection, complications, and clinical results.

A third Certificate of Merit was awarded to Lee A. Hadley, M.D., Syracuse, New York, for his exhibit entitled *Spondylolisthesis Studies*. Dr. Hadley emphasized the value of the roentgenogram taken at 45°. He described a "cross" shadow which assists in recognition of the neural arch defect. Osseous callus is frequently visualized as a mass projecting into the spinal canal opposite the neural arch defect. In the oblique films this is seen posteriorly. Instability and thinning of an intervertebral disc predisposes to reverse spondylolisthesis with foramen encroachment if the posterior articulations are intact. Disc instability with posterior joint destruction allows forward slipping, usually of L_4, the so-called pseudospondylolisthesis. Spondylolisthesis with intact neural arch is also seen with a congenitally elongated isthmus, or in cases of old healed fracture of that structure with a forward displacement of the vertebra. In the absence of lordosis an occult spondylolisthesis may be suspected in patients with a fifth arch defect wherein the fifth posterior articulation lies well posterior to the plane of the fourth. This type may be present in cases of unilateral defect. Rotary spondylolisthesis, a turning and slipping of the vertebra, is caused by an asymmetrical imbalance in the stabilization of the lower spine.

A fourth Certificate of Merit was awarded to the exhibit by J. E. Lofstrom, M.D., J. E. Webster, M.D., and E. S. Gurdjian, M.D., Wayne University College of Medicine, Detroit, Michigan, entitled *Angiography in Evaluation of Intracranial Trauma*. This exhibit showed representative angiograms obtained in the study of patients suffering cranial injuries. The characteristic patterns produced by epidural, subdural, and cerebral hematomas were demonstrated. A rapid effective method of diagnosis of these conditions was illustrated, with an analysis of cases obtained over a four year period.

The Abnormal Esophagus. Maurice M. Manalan, M.D., John A. Campbell, M.D., and William J. Little, M.D., U. S. Veterans Hospital, Indianapolis, Indiana. This exhibit was prepared as a teaching mechanism for graduate and post graduate students in Radiology at the Indianapolis Veterans Hospital and Indiana University Medical Center Hospitals. The material presented was arranged to bring out a systematic roentgen analysis of the normal esophagus, with special emphasis on the various pathological states encountered. An orderly classification of abnormalities with examples of practically all known pathological states of the esophagus was presented. The purpose of the exhibit was to acquaint the graduate and post graduate student with the variety of lesions in the esophagus, and to present to the experienced radiologist an interesting file of pathological material.

Visualization of the Coronary Arteries during Life. James A. Helmsworth, M.D., Johnson McGuire, M.D., Benjamin Felson, M.D., and Ralph C. Scott, M.D., Cincinnati General Hospital, Cincinnati, Ohio. Roentgenographic visualization of the coronary arteries has been successfully obtained in living dogs and in humans by insertion of a catheter into the proximal ascending aorta via the radial artery and injecting contrast media. The sites of previously ligated coronary artery branches have also been demonstrated in the experimental animals. The technique was described and films showing coronary artery filling were presented.

Microradiography of the Human Tuberculous Kidney. Wallace S. Tirman, M.D., Truman E. Caylor, M.D., and Harold D. Caylor, M.D., Caylor-Nickel Clinic, Bluffton, Indiana. The microscopic circulation of the human tuberculous kidney was demonstrated by microradiography. The kidneys were injected after nephrec-

tomy with an opaque medium (colloidal silver iodide). Roentgenograms were then made with a diffraction unit on a fine grain emulsion film. Enlargements were then made of these roentgenograms.

Bronchography Employing a Water Soluble Contrast Medium. D. D. Brannan, M.D., H. F. Inderlied, M.D., D. E. Wertman, M.D., and E. B. Kay, M.D., St. Luke's Hospital, Cleveland, Ohio. The exhibit reviewed experience with diodrast 50 per cent in 1.5 per cent methylcellulose and diodrast 50 per cent in 2.5 per cent carboxymethylcellulose, as contrast media for bronchography. The technique was described in detail and the advantages and disadvantages in comparison to the commonly used iodized oils were listed. Bronchograms in mounted transparencies demonstrated the results that can be achieved by this technique in the diagnosis and study of inflammatory and neoplastic bronchial disease.

Congenital Arteriovenous Anomalies. Charles T. Dotter, M.D., Israel Steinberg, M.D., Edward B. C. Keefer, M.D., and William Dubilier, M.D., Cornell University Medical College, New York, New York. The exhibit illustrated the angiographic appearance of various types of congenital arteriovenous anomalies involving arteries of the extremities, trunk, head, lungs and coronary system.

Interesting Alimentary Abnormalities in Infants and Children. Edward B. Singleton, M.D., and John F. Holt, M.D., University Hospital, Ann Arbor, Michigan. Although this exhibit contained many entities with which radiologists are thoroughly familiar, special emphasis was placed upon less common diseases which one is apt to encounter in a large teaching hospital with a very active pediatric service. It was hoped that the group of films assembled would have certain teaching value, particularly from the standpoint of a generalized review.

A Technique for Demonstrating the Internal Auditory Canals and Anterior Clinoids. J. M. Dell, Jr., M.D., Gainesville, Florida. Roentgenograms demonstrated the internal auditory canals, anterior clinoids and at times the posterior clinoids. A description of the technique was included.

Planigraphy in Carcinoma of the Larynx. A Comparison of the Planigrams with Surgical Specimens. C. L. Jackson, M.D., C. M. Norris, M.D., J. V. Blady, M.D., J. P. Moore, M.D., Temple University Hospital, Philadelphia, Pennsylvania. In contemplated surgery of the larynx roentgen examination is helpful to the operator in demonstrating the extent of involvement. This is particularly true in subglottic extension which is difficult to determine by other means. Illustrative cases were shown using planigrams and photographs of surgical specimens.

Surgical Treatment of Craniosynostosis. Franc D. Ingraham, M.D., Donald D. Matson, M.D., and Robert L. McLaurin, M.D., The Children's Medical Center of Boston, Boston, Massachusetts. This exhibit consisted of a summary of clinical and roentgen features of experience with 120 cases of premature fusion of the cranial sutures. Emphasis was placed on the importance of early recognition and surgical treatment to minimize mental retardation, visual loss and cranial deformity.

Hodgkin's Disease of the Skeletal System: Roentgen Diagnosis and Treatment. Lewis R. Lawrence, M.D., Harold G. Jacobson, M.D., Maxwell H. Poppel, M.D., and Bernard Roswit, M.D., Veterans Administration Hospital, Bronx, New York. For the past four and a half years every case of proved Hodgkin's disease observed in this hospital has been investigated in great detail. Numerous studies dealing with the various facets of Hodgkin's disease of bone have appeared in the literature. However, it seems that a purely roentgenographic approach to this problem with particular stress on the evolution of this type of involvement has not been emphasized and would be of considerable interest and value. In view of the large number of patients with Hodgkin's disease studied here (approximately 450 cases of whom 52 showed bone involvement) an impressive variety of bone lesions simulating virtually all known disease entities of the skeletal system has been observed.

Metastatic Malignancy and Simulating Lesions in Bones in Adult Males. Charles Oderr, M.D., and John E. Martin, M.D., Veterans Administration Hospital, New Orleans, Louisiana. Similar lesions of the same anatomical part are placed in juxtaposition. The film exhibition was accompanied by a large transilluminated chart indicating major differential diagnostic points. The demonstrated similarity of many lesions emphasizes the need to consider all diagnostic means, including the frequent use of biopsy.

Aortography; Preoperative and Postoperative Studies. A. Justin Williams, M.D., Tom M. Fullenlove, M.D., and John R. Bryan, M.D.,

Franklin Hospital, San Francisco, California. This exhibit consisted of preoperative and postoperative aortograms and arteriographic studies of cases showing partial or complete obstructive lesions in the abdominal aorta, pelvic and femoral vessels. A demonstratoin was given of the results obtained by endarterectomy and venous and arterial transplants.

Roentgen Search for Colon Polypi by High Voltage Technique. Cesare Gianturco, M.D., and George A. Miller, M.D., Carle Hospital Clinic, Urbana, Illinois. A technique of examining colons by overpenetrated films was presented with results obtained in the detection of polypi. Overpenetration technique with 100 kv. has been employed since 1937. However, since March, 1951, the voltage has been increased to 120 kv., this improving the results considerably.

Investigation of Cause of Lymphedema of the Upper Extremity after Radical Mastectomy; Changes in the Axillary Vein Demonstrated by Pre- and Postoperative Venograms. Peter E. Russo, M.D., J. R. Parker, M.D., and D. O. Osterreicher, M.D., University of Oklahoma School of Medicine, Oklahoma City, Oklahoma. Venograms of the axillary vein were done prior to radical mastectomy. Similar studies were done several days postoperatively. Studies to date show that in some cases the lumen of the axillary vein becomes narrow and irregular in outline and in other cases completely occluded. Evidence is being gathered that injury to this vein may be the principal cause of lymphedema of the arm which develops in these patients.

Correlation of Various Physical Means of Diagnosis of Intracranial Lesions. Rudolph J. Jaeger, M.D., John F. McGuire, M.D., Robert B. Jeffrey, M.D., and Paul C. Swenson, M.D., Jefferson Medical College and Hospital, Philadelphia, Pennsylvania. This exhibit consisted of a number of representative cases in which air studies, angiographic studies, electroencephalographic studies and isotope tracer studies have been made.

Roentgenology in Obstetrics and Gynecology. William Snow, M.D., Shreveport, Louisiana. Material was presented on roentgen pelvicephalometry, pelvic architecture, problems in engagement and at the mid-pelvic and fetal malformations. There was also included roentgen study of normal and abnormal soft tissues in obstetric and gynecological conditions. This was an original study based on over 16,000 patients subjected to roentgen examination.

Primary Hyperparathyroidism; a Study of 140 Consecutive Cases. L. B. Woolner, M.D., B. Marden Black, M.D., F. R. Keating, M.D., and David G. Pugh, M.D., Mayo Clinic, Rochester, Minnesota. The problems involved in the diagnosis and treatment of primary hyperparathyroidism cover a broad field of medical practice. The subject is of interest to and requires specialized knowledge on the part of the internist, roentgenologist, urologist, surgeon and pathologist. In past years many cases of primary hyperparathyroidism have undoubtedly been missed because of overemphasis on the skeletal aspect of the disease. For example, in their experience between 1928–1951 when the disease was suspected only among patients with severe skeletal disease, only 14 cases were discovered. However, between 1942–1951 when the disease was also suspected among patients with urinary calculi 126 cases were discovered. Accuracy of diagnosis is important because of the development of serious and frequently irreversible renal disease in neglected cases. The exhibit was based on experience over a period from 1928 to 1951 inclusive and included (a) clinical recognition of primary hyperparathyroidism; (b) roentgenologic manifestations of the disease; (c) pathologic findings; and (d) surgical technique.

Clinical Use of a Flavonoid Compound for Protection of the Skin against Radiation Damage. Isidore Arons, M.D., Solomon Weintraub, M.D., John W. Freeman, M.D., Abraham Oppenheim, M.D., and Robert T. Williams, B. S., Harlem City Hospital, New York, New York; and Boris Sokoloff, M.D., and Walter Eddy, M.D., Florida Southern College, Lakeland, Florida. The presentation consisted of color transparencies of the skin of patients treated with deep radiation therapy and protected by the use of a flavonoid compound derived from citrus fruits.

Cancer of the Cervix—New Developments in the Use of the Expanding Single Unit Type of Radium Applicator. Edwin C. Ernst, M.D., and Edwin C. Ernst, Jr., M.D., Barnard Free Skin and Cancer and DePaul Hospitals, St. Louis, Missouri. The more recent clinical developments in the technical application of multiple radium sources, in the treatment of carcinoma of the cervix, when combined in a single flexible applicator, were illustrated by means of practical dosage charts, simplified

dosage measurement diagrams for gamma roentgen computations, photographs of new technical procedures and colored photographs of variable dosage effects upon the primary lesion.

Dosimetry in Radium Therapy of Carcinoma of the Cervix. Gilbert H. Fletcher, M.D., Robert J. Shalek, M.A., and Arthur Cole, B.A., University of Texas, M.D. Anderson Hospital for Cancer Research, Houston, Texas. A method of clinical dosimetry of carcinoma of the cervix was presented. Included were a display of the metal applicators (ovoids) with differential screening, the intracavitary scintillation probe, and an automatic isodose recorder for gamma-ray sources. A method of reconstructing the applicator position, and a dose finder for evaluating individual treatments were also shown, as well as a number of case roentgenograms with clinical comments.

The Prognosis for Survival in Chronic Granulocytic and Lymphocytic Leukemia. Harold Tivey, University of Oregon Medical School, Portland, Oregon. Survival data in chronic leukemia have been collected and analyzed from 46 "series" totaling over 2,600 "patients." Results for both the individual series and for the combined data were presented. Results of titrated, regularly spaced, total body irradiation (Osgood and Seaman) were compared with the experience from the literature. The distribution of survival times, before therapy, after therapy and total survival are skewed (log-normal) curves. The maximum-likelihood method of analysis used, of J. W. Boag and D. E. Lea, permits prediction of final results *before all patients are dead* and is applicable to analysis of survival statistics of patients dying of carcinoma and many other medical and surgical diseases. Examples of survival in these diseases were shown for comparison with survival in leukemia.

Roentgen Irradiation of Inoperable Cancer by the Non-alternate Chessboard or Sieve Method; Comparative Results with Other Methods. Hirsch Marks, M.D., Welfare Island Dispensary, New York, New York. The four, twelve and eighteen year survival of 3 patients treated with roentgen irradiation through a grid, conventional roentgen therapy and teleradium respectively, points to, among other things, a common denominator, homogeneity, as the most potent single factor in effecting these cures. Two hundred kilovolt radiation rendered more homogeneous with the use of the grid recently introduced by the author was instrumental in effecting a four year survival of an inoperable carcinoma of the vulva with metastases to the left inguinal lymph nodes. In conventional roentgen therapy, protracted treatments, with periods of respite, serve as a corrective for the relative inhomogeneity of radiation in the same range as above. Protracted conventional roentgen irradiation with periods of respite from treatment dictated by the excessive absorption of scatter, incidental to large open field roentgen therapy, was responsible for the twelve year survival of an inoperable neurofibrosarcoma of the left neck. Teleradium therapy of an inoperable sarcoma of the left antrum, complicated with pregnancy, effected lysis of the malignant process and eighteen year survival of the mother and child by the action of the most homogeneous radiation, gamma rays.

Radiation Treatment of Carcinoma of the Corpus Uteri. William E. Costolow, M.D., James F. Nolan, M.D., G. Charles Budenz, M.D., and Lucille Dusault, A.B., Los Angeles Tumor Institute, Los Angeles, California. Charts in color were presented of a series of 249 patients with carcinoma of the corpus uteri treated primarily by radiation therapy either alone or supplemented by hysterectomy, at the Los Angeles Tumor Institute, between the years 1933 and 1951 inclusive. The end results obtained were correlated with radiation dosage. The factors influencing prognosis, such as stage of the disease grossly, the histopathologic grade and the age of the patient, were explored in the light of the amount of treatment given.

Carcinoma of the Thyroid; Morphological Form and Tracer Pattern in Thyroid Malignancy. William L. Brosius, M.D., Lawrence Reynolds, M.D., K. E. Corrigan, Ph.D., and H. S. Hayden, Ph.D., Harper Hospital, Detroit, Michigan. Carcinoma of the thyroid assumes many different forms varying from the histological appearance of normal thyroid tissue to subtle abnormalities sometimes simulating malignancy of other origin. It can appear anywhere in the body and give many presenting symptoms suggesting some entirely different disease process. Tracer study aids in identification of thyroid carcinoma in vivo.

Atomic Medicine for Diagnosis and Therapy. Henry L. Jaffe, M.D., Cedars of Lebanon Hospital and University of Southern California Medical School, Los Angeles, California. A summary of the diagnostic and therapeutic

uses of radioactive iodine (I^{131}) was presented, including (1) study of thyroid function; (2) treatment of thyrotoxicosis; (3) treatment of thyroid cancer; (4) treatment of euthyroid cardiac disease. The therapeutic uses of radioactive phosphorus were summarized, showing (1) treatment of polycythemia vera; (2) treatment of chronic leukemias; (3) treatment of advanced cancer with pleural effusion or ascites by intrapleural and intraperitoneal injection of colloidal chromic phosphate; (4) treatment of chronic cutaneous and subcutaneous ulcers with radioactive phosphorus ointment.

The Handling of Radioactive Gold 198 for Therapeutic Purposes. Michel M. Ter-Pogossian, Ph.D., Alfred I. Sherman, M.D., Willard Allen, M.D., and William B. Seaman, M.D., Departments of Radiology and Gynecology, Washington University, St. Louis, Missouri. This exhibit featured the necessary equipment and techniques used in the handling of radioactive gold 198 for therapeutic purposes. The different steps leading to the injection of the gold were described in detail. Some clinical applications of this isotope were shown. The rate and amount of selective concentration of colloidal gold in lymph nodes and biological effects obtained were shown in a series of animal experiments.

Electrical Working Model of X-Ray Machine. Clark Hickman, B.S., Joe C. Rude, M.D., and Jesse B. Johnson, M.D., University of Texas, Medical Branch, Department of Radiology, Galveston, Texas. This exhibit consisted of a bread-board model of a roentgen machine used in the U. S. Army Schools of Roentgenology. An oscilloscope was used to show the type current produced by half wave and full wave rectification. This machine does not generate roentgen rays, and no high voltage is developed. Radio rectifier tubes are used for this purpose. This is operated from standard A.C. 110 V wall outlet.

Rapid Sequence Cassette Changers for Angiography; Improved Single and Bi-plane Multiple Cassette Changers for Contrast Angiography. J. A. Campbell, M.D., and P. O. Patterson, Indiana University Medical Center, Indianapolis, Indiana. For those who do not have a large volume of angiographic work there is need for low cost equipment which will handle conventional cassettes and utilize regular darkroom procedures. This exhibit demonstrated a bi-plane rapid cassette changer for cerebral angiography which is hand operated. A motor driven bi-plane angiocardiographic unit was also shown. These machines were developed in the Department of Radiology of Indiana University Medical Center.

COMMERCIAL EXHIBIT

As is customary, a Commercial Exhibit was held in conjunction with the Fifty-third Annual Meeting of the American Roentgen Ray Society at the Shamrock Hotel, Houston, Texas, September 23 to 26, 1952. The building in which the Commercial Exhibit was housed was separate from the hotel, being especially constructed for such a purpose. The arrangement of the exhibit hall was excellent and adequate space was available. The manufacturers showed much interest in the fact that the meeting was scheduled for a part of the country where the Society had never been before, and Houston's fame as a rapidly growing medical center added to the enthusiasm of the exhibitors. As a result, the Commercial Exhibit at Houston was the largest that the Society has ever had. It was extremely well arranged and disposed, there being on display an unusual array of new apparatus of great interest to all radiologists.

The Society extends its thanks and appreciation to the exhibiting firms for their part in notably contributing to a most successful meeting.

The following firms were represented in the Commercial Exhibit:

Amperex Electronic Corporation, Brooklyn, New York; *Ansco*, Binghamton, New York; *Bar-Ray Products, Inc.*, Brooklyn, New York; *Buck X-Ograph Company*, St. Louis, Missouri; *Continental X-Ray Corporation*, Chicago, Illinois; *Coreco Research Corporation*, New York, New York; *E. I. du Pont de Nemours & Company, Inc.*, Wilmington, Delaware; *Eastman Kodak Company*, Rochester, New York; *Eureka X-Ray Tube Corporation*, Chicago, Illinois; *Fairchild Camera and Instrument Corporation*, Jamaica, New York; *Franklin X-Ray Corporation*, Philadelphia, Pennsylvania; *General Electric Company*, Milwaukee, Wisconsin; *Grune & Stratton, Inc.*, New York, New York; *Halsey X-Ray Products, Inc.*, Brooklyn, New York; *Keleket X-Ray Corporation*, Covington, Kentucky; *Lea & Febiger*, Philadelphia, Pennsylvania; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories, Inc.*, Springdale, Connecticut; *F. Mattern Manufacturing Company*, Chicago, Illinois; *Medical Equipment*

Company, Limited, Henderson, Texas; *Micro X-Ray Recorder, Inc.*, Chicago, Illinois; *North American Philips Co., Inc.*, Mt. Vernon, New York; *Pako Corporation*, Minneapolis, Minnesota; *Picker X-Ray Corporation*, White Plains, New York; *Professional Equipment Company*, Maywood, Illinois; *W. B. Saunders Company*, Philadelphia, Pennsylvania; *Schering Corporation*, Bloomfield, New Jersey; *Frank Scholz X-Ray Corporation*, Boston, Massachusetts; *Standard X-Ray Company*, Chicago, Illinois; *Charles C Thomas, Publisher*, Springfield, Illinois; *Tracerlab, Inc.*, Boston, Massachusetts; *United States Radium Corporation*, New York, New York; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse Electric Corporation*, Pittsburgh, Pennsylvania; *Winthrop-Stearns, Inc.*, New York, New York; *Year Book Publishers, Inc.*, Chicago, Illinois.

NEW OFFICERS AMERICAN ROENTGEN RAY SOCIETY

At the Fifty-third Annual Meeting of the American Roentgen Ray Society held at the Shamrock Hotel, Houston, Texas, September 23–26, 1952, the following officers were elected for the year 1952–1953: *President-Elect:* Dr. Harry M. Weber, Rochester, Minnesota; *1st Vice-President:* Dr. Fred O. Coe, Washington, D. C.; *2nd Vice-President:* Dr. Lester W. Paul, Madison, Wisconsin; *Secretary:* Dr. Barton R. Young, Philadelphia, Pennsylvania (re-elected); *Treasurer:* Dr. Wendell G. Scott, St. Louis, Missouri (re-elected); *Member of the Executive Council:* Dr. W. Edward Chamberlain, Philadelphia, Pennsylvania. The *President* is Dr. Charles L. Martin, Dallas, Texas, and the *Chairman of the Executive Council* is Dr. Clyde A. Stevenson, Temple, Texas.

SEVENTH INTERNATIONAL CONGRESS OF RADIOLOGY, 1953

The *Preliminary Programme* of the Seventh International Congress of Radiology to be held in Copenhagen, Denmark, from July 19 to 25, 1953, was sent in June, 1952, to 12,000 radiologists throughout the world. Anyone failing to receive a copy should write to the Congress Office (Øster Voldgade 10, Copenhagen K, Denmark; Cable address: Radiology, Copenhagen), stating whether they would prefer the English, French, German, or Spanish version.

It would be greatly appreciated if potential members would *enroll as early as possible* so that their applications may be dealt with promptly. Too many enrollments on and around the closing date (January 1, 1953) will cause delay.

Applications for *hotel accommodations* should be sent on Form B to the Congress Office at the time of enrollment. First class hotel accommodations will be limited but priority will, for the most part, be given to those who apply early.

Those *proffering papers* are requested to enclose *three* copies of their abstracts, which may be submitted in either English, French, or German (one language only).

Members bringing *cars* are advised to indicate this on enrollment.

General Meetings

1. Potential developments in radiology
2. Contrast media in diagnosis and risks associated therewith
3. Radioresistance
4. Protection against ionizing radiations
5. Uniformity in therapeutic cancer statistics

Section Symposia

Diagnosis

1. Angiocardiography
2. Tumors of the lung
3. Osteochondrosis of the spine
4. Tomography

Therapy

1. Radioactive isotopes in medical therapy
2. Present status of radiotherapy in benign diseases
3. The radiation syndrome
4. Cancer of the cervix uteri

Biology

1. Chemotherapy of cancer
2. Isotopes in biology
3. Intracellular radiation action
4. Pathogenesis of leukemia

Physics

1. Recent advances in the diagnostic applications of the fluorescent screen
2. Moving field therapy
3. Integral dose

Technology

1. Diagnosis with high voltage rays
2. The photoelectric timing of x-ray exposures
3. Rapid serial angiography
4. High voltage particle accelerators

FLEMMING NØRGAARD
Secretary-General

MEDICAL RESEARCH FELLOWSHIPS

The Division of Medical Sciences of the National Research Council announces the following postdoctoral research fellowships for 1953–1954:

Fellowships in the Medical Sciences. There are two groups of these fellowships, one supported by The Rockefeller Foundation, and another by The Lilly Research Laboratories. Both are administered by the Medical Fellowship Board of the Division of Medical Sciences. These awards are designed to offer advanced training in the preclinical sciences, and not to provide practical experience in the clinical field. Applicants with clinical experience who are seeking fellowships with the objective of entering clinical investigation will be expected during the period of appointment to devote themselves to research in the basic medical sciences. The fellowships are intended for recent graduates who, as a rule, are not more than thirty years of age. Fellows must hold the M.D. or Ph.D. degree. The Rockefeller Fellowships are open to citizens of the United States and Canada, the Lilly Fellowships only to citizens of the United States.

Fellowships in Tuberculosis are available under a grant from the National Tuberculosis Association. These awards also are administered by the Medical Fellowship Board, and are designed to promote the training and development of investigators in fields related to tuberculosis. They are open to citizens of the United States who are graduates of American Schools and who, as a rule, are not more than thirty years of age. Preference will be given to applicants who have the M. D. or Ph.D. degree; only in exceptional circumstances will a fellowship be awarded to an applicant without either of these degrees.

Fellowships in Radiological Research are administered by the Division for the James Picker Foundation. Applications are reviewed by the Committee on Radiology of the Division. The recommendations of the Committee are transmitted to the Board of Directors of the Foundation for final determination of awards. These fellowships offer research training for recent graduates who, as a rule, are not more than thirty years of age, and who are entering upon investigative careers in the field of radiology. The Foundation has expressed particular interest in the support of candidates who propose to carry on research oriented toward diagnostic aspects of radiology. Fellows must hold the M.D. or Ph.D. degree. Appointments are not limited to citizens of the United States.

The *Committee on Growth* of the Division of Medical Sciences advises the American Cancer Society regarding the award of Fellowships in Cancer Research. Announcement of this program has been published separately.

Applications for 1953–1954 must be postmarked *on or before December 10, 1952.* Fellowships are awarded in the late winter or early spring. Complete details and application blanks may be obtained from the *Fellowship Office, National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C.*

To the Editor:

Investigators working in the field of Diagnostic Radiology have been neglecting an opportunity for support made available to them by the James Picker Foundation. This Foundation with a present capital of almost a million dollars has now disbursed approximately $100,000.00, most of it on projects concerned with radiation therapy. Up to the present about 60 per cent of the applications have been for primarily therapeutic projects, 22 per cent for borderline projects and only about 18 per cent for primarily diagnostic projects. We believe that the founders have been glad to support therapy in the past and intend to continue to do so in the future but we agree with them that there should be a better balance between therapy and diagnosis.

There are now well financed private and government agencies prepared to support research in neoplasm but few donors are interested in research in diagnostic radiology that is not concerned with neoplasm. We, the undersigned, who with other radiologists from time to time have assisted in evaluating proposals submitted to the Picker Foundation, urge that investigators consider this fund when they need financial support for research in the field of diagnostic radiology.

W. Edward Chamberlain, M.D.
H. Dabney Kerr, M.D.
Eugene P. Pendergrass, M.D.
Paul C. Hodges, M.D.
Russell H. Morgan, M.D.
Robert J. Reeves, M.D.
Wendell G. Scott, M.D.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Benjamin H. B. The neurovascular mechanism of the mucous membrane of the stomach. *Surg., Gynec. & Obst.*, Dec., 1951, *93*, 672–675.

The vascular pattern of the unstimulated stomach and that of the stimulated stomach as shown by microradiography and microphotography are compared. In the unstimulated stomach the pyloric mucous membrane contains a tremendous network of interanastomosing blood vessels that extend to the limits of the mucous membrane. In the stimulated stomach few of these fine vessels are apparent whereas the large vessels arising from the loose areolar vascular highway stand out sharply. These main vessels show numerous shunting channels arranged like the steps of a ladder. It is clearly apparent how unfiltered impulses over the right vagus keep the mucous membrane in a state of anemia because of this shunting and therefore lead to ulcer formation.—*Mary Frances Vastine, M.D.*

Leb, A. Die Röntgenuntersuchung des resezierten Magens mit Eiweiss- und Fett-Bariumkernen. (Roentgen examination of the resected stomach by means of protein and fat barium particles.) *Fortschr. a. de. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, Supp., 106–116.

Roentgenographic examination of 300 cases after gastric resection failed to show evidence of an ulcer or gastritis of the stump despite a suggestive history and physical findings. It was therefore decided to investigate such patients from a roentgenological-physiological standpoint. Various substances, such as fat and protein, were enclosed in a suitable protective shell, 0.5–1.5 mm. in thickness. Such a shell had to be water-insoluble, unaffected by body temperature, and resistant to the mechanical influences of the gastrointestinal tract but would be altered only after contact with gastric or intestinal juices.

The indicators consisted of round or oval, dry, barium particles about 5 mm. in diameter, readily soluble in a mixture of starch and water. The fatty substance employed was beef fat, whose melting point is 42–49° C. The protein in the experiments was actomyosin, derived from rabbit muscle. In each examination, 3 pellets of a fat-barium and 3 of a protein-barium mixture were used. These were swallowed whole and the particles in each group had to undergo identical changes for the study to be acceptable. The patient was fluoroscoped at one-half to two hour intervals in order to observe the time and place of the disintegration of the particles. If more than four or five hours elapsed before dissolution of the fat, a pathological fat metabolism was diagnosed. A more severe disturbance was denoted if the fat reached the colon unchanged. Faulty protein metabolism was indicated by failure of the protein particles to dissolve after one and one-half to two hours.

The following conclusions were drawn: (1) rapid passage through the stomach and duodenum permits insufficient time for proper digestion; (2) the fat-barium particles are digested in the distal ileum but sometimes reach the colon unchanged; (3) the protein experiments indicate that after gastrectomy, the trypsin replaces pepsin in the metabolism of this foodstuff.—*Joseph Zausner, M.D.*

Capurro, Federico Garcia, and Pecantet, Juan Carlos. Étude radiologique par collapsus de la chambre gastrique. (Roentgen study of the stomach following induced collapse.) *Presse méd.*, Dec. 25, 1951, *59*, 1764–1765.

The superior portion of the stomach is difficult to study and is where cancers are more often missed. The authors have followed their routine examination with an underexposed film of this region. However, when special studies are indicated, the procedure is to collapse the distended cavity of the greater curvature so that it is like the potential cavity of the remainder of the stomach. This is done either by pneumoperitoneum with air manipulated into the left upper quadrant or aspiration of air by means of a catheter introduced into the stomach. Rarely both procedures are necessary. Barium is then given by mouth in the usual way and a satisfactory mucosal pattern is obtained.—*M. L. Sussman, M.D.*

LaPointe, Henri. Diaphragmatic hernia. *J. Canad. A. Radiologists*, Dec., 1951, *2*, 65–69.

The writer reports on the clinical and roentgenographic findings of 6 consecutive cases of diaphragmatic hernia. With the exception of one which had been suspected clinically, all of the other cases were discovered incidentally during routine roentgen examination of the chest or abdomen without contrast medium. The author stresses that "the clinical recognition of diaphragmatic hernia from the subjective symptoms alone is often very difficult, and only the roentgen ray examination can be depended on to clear up the diagnosis." There is little doubt that the clinical complaints are usually attributed to some disorder of one of the intrathoracic or intra-abdominal viscera. Various degrees of pain in the region of the stomach, eructation, vomiting and/or anorexia may dominate the picture, and draw attention to trouble in the upper digestive tract.

Symptoms of diaphragmatic hernia are often so bizarre that palpitation, fainting spells and precordial distress may be attributed to a heart condition, whereas hernia into the posterior mediastinum,

the real cause, will be overlooked. Loss of weight and anorexia are generally reported by the patient, but these have no real significance, and could very easily be caused by a variety of other pathological entities. One of our patients complained of "gas noises" in her chest.

Subjective symptoms of diaphragmatic hernia may be totally lacking; or they may be so mild that little does the patient suspect that his stomach is not just where it should be or that his colon has intruded into a region where his heart alone belongs.

Certain respiratory disturbances, such as cough, dyspnea and polypnea, are no more typical of diaphragmatic hernia than they would be for the majority of respiratory diseases. The cough associated with diaphragmatic hernia, however, is peculiar, and if reported by the patient may be suggestive. It comes on in paroxysms, is nonproductive, has a tendency to exhaust the patient by increasing the intrathoracic and intramediastinal pressure. Others complain of hiccough.

Physical signs are also very deceptive. Abdominal palpation is for the most part noninformative; but, on the contrary, chest signs may be more revealing and are therefore worthy of note:

(a) On percussion, in hernia on the left side, dextrocardia is always present in some degree.
(b) Heart sounds may be clearer on the right.
(c) There may be an entire absence of breath sounds on the affected side.
(d) On auscultation there is a mixture of sounds, such as gurgling, suggestive of peristalsis.
(e) The physical signs will vary with the amount of food, water, or air in the stomach and bowel.

Most of the time, the presumptive diagnosis should be made from routine roentgenograms of the chest made in the posteroanterior and lateral views. Some atypical shadows will be apparent in a lung field or the mediastinum. At times there may be an area of irregular opacity at the base of one lung or occupying the whole of an hemithorax and not concordant with the clinical findings. Translucent areas with or without fluid levels are sometimes visible, and compare with the intestinal or gastric morphology. Retrosternal gas pockets are a striking feature. These shadows may be totally modified in their disposition from one film to another. The contour of the diaphragmatic dome may be obscured on one side. A dense circular shadow may be superimposed upon the heart shadow, and caused by the wall of the herniated upper portion of the stomach. The heart appears displaced to the side opposite the hernia.

In conclusion, the writer states that "the incidence of diaphragmatic hernia is probably much greater than we were at first led to believe. Atypical shadows in the chest area should prompt the clinician and radiologist to compare notes, especially if the abnormality suggested by these shadows does not seem to correspond to the clinical entity. In doubtful cases there should be no hesitation in controlling the preliminary roentgenological findings by a barium study."—*R. F. Niehaus, M.D.*

Sansone, G., Macarini, N., and Oliva, L. Nouvelle méthode d'exploration radiologique du pancréas chez l'enfant. (New method of roentgen examination of the pancreas in children.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1951, *32*, 726–733.

After a review of the few attempts to produce direct roentgenographic visualization of the pancreas, the authors describe a new method which they have tried in adults (Macarini and Oliva, *Informatore med.*, 1951, *5*, 29) and which they now for the first time have successfully used in children.

The method consists of a combination of retropneumoperitoneum and inflation of the stomach, associated with frontal, sagittal and transverse axial laminagraphy.

The examination is performed on an empty stomach, without any preparation. Oxygen is used for the retropneumoperitoneum which is carried out according to the procedure of Ruiz-Rivas with certain modifications. A total of 400 to 500 cc. is injected, half with the patient lying on the right side and half with the patient lying on the left side. The child is then kept in ventral decubitus for ten to fifteen minutes, the trunk being somewhat higher than the pelvis. The stomach is inflated by administering 2 grams of sodium bicarbonate and 1 gram of tartaric acid. Conventional roentgenograms, as well as laminagrams in the frontal, sagittal and transverse axial planes are made with the patient standing.

The authors give the detailed case records of 2 children, one six and the other twelve years of age, in whom the method enabled a very satisfactory demonstration of the pancreas. The pertinent roentgenograms and laminagrams are reproduced and the essential findings are illustrated by schematic drawings.

In general, the conventional posteroanterior and anteroposterior roentgenograms, as well as the frontal laminagrams, fail to reveal the presence of the pancreatic shadow. The conventional lateral roentgenogram (with the left side to the film) sometimes gives the impression of a faint shadow which, however, is insufficient for accurate diagnosis. The best visualization is obtained by sagittal and transverse axial laminagraphy. The former permits a demonstration of the pancreas in successive layers from head to tail, whereas the latter nearly always renders the entire pancreas visible in a single layer. By harmonizing all of the findings, it is possible to gain valuable information not only as to the size, shape and location of this organ but also as to its relationship to other viscera of the upper abdomen.

In concluding. the authors express their belief that the new method will add considerably to the value of the roentgen examination in various lesions of the pancreas.—*T. Leucutia, M.D.*

Berg, H. H. Über einige akute Bauchsyndrome in der Inneren Klinik und ihre Röntgendiagnostik. (Certain acute abdominal syndromes encountered in the Medical Clinic and their roentgen diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, Supp., 1–9.

The author wishes to remind the reader that acute abdominal symptoms can be diagnosed and differentiated often with the help of a satisfactory roentgen examination. This does not apply only to surgical conditions but may also be of importance in many medical situations. Diseases of the pancreas, disturbances of metabolism, peritonism, perforation, hemorrhages and various diseases of the bile system fall into this group.

For example, distention of the stomach and the colon is often found in inflammatory diseases in the upper abdomen, such as an acute pancreatic necrosis, and also precedes and follows complications of surgery of the gallbladder. Such conditions should be considered particularly when the distention is associated with atelectasis in the lower lobes of the lungs.

It is not commonly known that a diabetic coma may be accompanied by acute abdominal symptoms such as vomiting and pain and that a roentgen examination in such a condition will almost regularly show a considerable dilatation and distention of the stomach which promptly subsides with appropriate treatment of the underlying condition. A distention of the stomach similar to that seen in a diabetic coma can also be observed in hepatic or uremic coma.

The acute dilatation of the stomach often seen to follow surgical procedures and thought to be due to pressure from the superior mesenteric artery upon the duodenum can be explained now on the basis of disturbance of metabolism such as acidosis, etc.

An acute peritonism in cancer of the stomach can give similar roentgenological appearances when inflammatory changes within the tumor cause peritoneal irritation.

A perforated ulcer can be diagnosed early with the help of a good roentgenological examination. A diffuse peritonitis occurs only in a limited number of such cases but the early recognition of the pneumoperitoneum is of great clinical significance and can be obtained best by films in the upright position.

The author does not advocate an early examination for a gastric hemorrhage and advises a wait of ten to fourteen days after the bleeding has subsided. An earlier roentgenological examination is justified only in those cases in which an immediate operation seems to be indicated. One must be careful in such cases to differentiate between coagulated blood in the stomach and filling defects produced by polyps and tumors. Coagulated blood is usually freely movable and is not present after the fourth day following the bleeding.

An esophageal ulcer only rarely causes bleeding. Such bleeding is usually due to esophageal varices which can be easily demonstrated by an adequate roentgen examination.

An empyema of the gallbladder can often be diagnosed early by the high position of the diaphragm, by atelectasis in the base of the lungs, and sometimes by accompanying subphrenic abscesses or a possible perforation into the pleural cavity. A liver abscess can give similar appearances and also can perforate into the pleural cavity.

The findings of gas in the biliary system are of important diagnostic value and not rare at all. They may be caused by inflammatory processes such as an abscess in the liver but are more commonly due to a communication between the bile system and the intestines. The diagnosis of gallstone ileus, for instance, can easily be made with the aid of such findings.

Postoperative cholangiograms are very helpful in the diagnosis of retained common duct stones or postoperative strictures of the common duct. The persistence of a stricture or a stenosis of the common duct may lead to cholangitic cirrhosis of the liver and other severe complications if left unattended.

The radiologist should recognize that great care must be employed in any examination for an acute condition of the abdomen and that such an examination should be done only in accordance with the patient's symptoms and general condition. Many too strenuous examinations may be dangerous for a seriously ill patient and may therefore discredit a good examination as such.—*H. P. Mueller, M.D.*

Vespignani, Luigi. The roentgen reticular appearance of the perirenal fat tissue in extraperitoneal pneumoabdomen (retropneumoperitoneum) and tomography. *Acta radiol.*, Dec., 1951, *36*, 509–515.

The author describes the roentgen appearances of the perirenal fat tissue seen when extraperitoneal pneumoabdomen (retropneumoperitoneum) examinations are combined with laminagraphy.

The kidney does not lie free in fibrous fascia. Numerous connective fibers link the external renal surface to the internal surface of the perirenal fascia. This connective tissue, loose and frail, but very abundant, grows rich in fat about the eighth to tenth year of life and is thus transformed into the renal fatty capsule.

Perirenal fat varies in quantity in different subjects. It is scanty or almost lacking on the anterior surface of the kidney. On the posterior surface of the kidney, particularly at the level of the poles, it forms a layer about 2 to 3 cm. thick.

On the examination (pneumoabdomen associated with laminagraphy), a reticular formation surrounding radiolucent polygonal or ovoid areolae is seen superimposed on the renal shadow or situated on its borders in the clear space produced by the gas in the kidney bed. It is believed that the connective

fibers of the fatty tissue correspond to the strands of connective tissue, while the fat lobules correspond to the clear polygonal areolae.

The importance of realizing that this reticulation is a normal finding is obvious. It should not be interpreted as adhesions due to perinephritis.—*Mary Frances Vastine, M.D.*

SOMERVILLE, PHILIP. Gas cysts of the intestine with pneumoperitoneum. *Lancet*, Dec. 22, 1951, *2*, 1160–1161.

The case of a fifty-five year old female with chronic ulcer causing pyloric obstruction complicated by pneumoperitoneum is discussed in some detail. The theories as to cause of pneumotosis cystoides are reviewed.

In this instance, the patient complained particularly of aerophagy. The author seems to feel that swallowed air is forced through a rent in the mucosa by repeated vomiting and belching. Once in the layers of the bowel wall, air may be passed along by peristalsis and may actually enter the lymphatics or retroperitoneal space.—*J. D. Reeves, M.D.*

JONES, W. A., and CONNELL, W. FORD. Henoch's purpura; its radiological diagnosis. *J. Canad. A. Radiologists*, Dec., 1951, *2*, 56–59.

Edouard Henoch, a German pediatrician, reported 4 cases of purpura in children in 1874 and described it as a distinct clinical entity. "Characteristic for all is the combination of purpura and the striking intestinal symptoms which are present in the form of colic, tenderness of the abdomen, vomiting, and in hemorrhages, rheumatoid pains and swelling. Characteristic furthermore is the appearance of these symptoms in attacks with an interval of eight days or more, so that in the usual cases, 3 to 7 weeks pass before the process clears up; in the last case, indeed, more than 3 months."

The authors describe a patient with Henoch's purpura in which the striking intestinal symptoms antedated the purpuric manifestations by almost six weeks. Their case report illustrates the difficulties encountered in the early clinical diagnosis of this type of purpura. The writers are careful to point out that other authors before them had described the aid which gastrointestinal roentgen examination afforded in cases of Henoch's purpura. Thus, they refer first to Whitmore and Peterson's article: "Henoch's purpura; small intestinal changes" (*Radiology*, 1946, *46*, 373–376). They also give references to several other authors who have reported the abnormal small bowel roentgenologic pattern in Henoch's purpura.

The roentgenologic findings are described as an alteration in the normal mucosal pattern of the small intestine with a tendency to stasis and irregularity of the intestinal outline resembling small diverticula and ulcers. In the authors' case report, a gastrointestinal study (made about two weeks after the onset of illness) revealed the following: "The pyloric portion of the stomach and the duodenum was rather rigid, narrowed, and their silhouette irregular, inversely scalloped and notched. The mucous membrane pattern was abnormal or lost. There was stasis in the greater portion of the duodenum; the rest of the duodenum and a portion of the jejunum showed similar changes with less marked filling. This pattern was exactly re-duplicated on several films at this examination. This was reported at the time as due to an inflammatory lesion of the stomach, duodenum and jejunum." The authors' case report is of unusual interest because they have done periodic gastrointestinal studies over a four year period. Two years after the patient's illness, the distal duodenum and jejunum were poorly filled and presented a "ravelled string" appearance. Some segmentation of the small bowel was also seen. A gastrointestinal study made four years after the original illness is described as normal. The article is well illustrated with five reproductions of the stomach, duodenum, and jejunum taken at intervals over a four year period.

In summary, the authors present their case as another example of the difficulties encountered in the early clinical diagnosis of Henoch's purpura. They stress the information which the roentgen examinations can give when this clinical entity is kept in mind. These examinations should afford a clue to the correct diagnosis and thus avoid an unnecessary exploratory operation.—*R. F. Niehaus, M.D.*

DEUCHER, W. Reliefuntersuchung am Dünndarm. (Mucosal relief study of the small intestine.) *Schweiz. med. Wchnschr.*, Dec. 8, 1951, *81*, 1194–1196.

Detailed study of the mucosa of the small intestine is a necessary adjunct to fluoroscopy and routine roentgenographic examination. The technique of the examination has to be standardized since addition to the plain barium sulfate meal or premedication may alter the results considerably.

The author first mentions the peristaltic pattern (so-called "auto-relief") of the normal small bowel. Its thin mucosal folds are vertical except in areas which are contracted or compressed where they may be longitudinal. Thickened folds are seen in abdominal inflammations such as, for instance, appendicitis.

The author then describes the well known changes in malignant tumor of the small bowel with complete loss of the mucosal pattern and narrowing of the bowel. He states that similar changes can be seen in advanced stages of inflammatory disease and the differential diagnosis may be difficult. In inflammatory disease, the degree of the change of the mucosal pattern corresponds to the severity of the disease. Subacute enteritis causes slight widening of the mucosal folds. A similar appearance might be seen in parasitic disease and in cases of mushroom or lead poisoning. The most extensive mucosal changes are

seen in regional enteritis and tuberculosis where rigid walls are present. The differential diagnosis between these two conditions might be difficult. In favor of tuberculosis is the involvement of the cecum.

Deficiency disease causes the so-called "deficiency pattern." its extent corresponds to the severity of the disease.

The author finally discusses the intestinal reaction to emotional disturbances which commonly affect the motility of the small bowel.—*E. G. Wissing, M.D.*

Spear, Harold C., and Brainard, Scott C. Cancer of the large bowel; an analysis of 580 lesions. *Ann. Surg.*, Dec., 1951, *134*, 934–945.

In this series 568 patients presented 580 cancers of the large bowel. This experience includes all patients with cancer of the colon seen at New Haven Hospital between 1922 and 1949 inclusive. The resectability rate was 56.8 per cent. The operative mortality was 9.6 per cent but with intestinal antiseptics, antibiotics and anticoagulants this rate was reduced to 4.4 per cent in the final five years.

Of those who were operated upon with the thought of curative resection, 37.9 per cent survived five years or longer; for right colonic lesions, 65.5 per cent survived five years. Lymph node involvement decreased five year survival rate by 17.2 per cent (with negative lymph nodes 49.5 per cent survived and with positive lymph nodes 32.3 per cent survived).

Roentgen findings were accurately diagnostic in 238 of 309 examinations, excluding rectal lesions. The majority of the false negative diagnoses occurred during the earlier years of the series.—*J. W. Turner, M.D.*

Cifuentes Delatte, Luis, and Albalá, Ignacio. Fístulas recto-uretrales congénitas. (Congenital recto-urethral fistulas.) *Arch. españ. urol.*, 1951, *7*, 101–113.

Recto-urethral fistulas generally do not present as isolated malformations but as part of a number of anomalies the essential characteristics of which are: (1) imperforate anus and (2) persistence of a fine cloacal duct. The most severe and most exceptional cases do not show even this fine communicating cloacal duct, but exhibit a veritable common cloacal cavity, *i.e.*, a persistent cloaca.

The diagnosis is made through systematic surgical exploration in every case of imperforate anal canal as soon as the abnormality is discovered. Nevertheless, the presence of a recto-urethral fistula may be suspected by anyone who recognizes the frequency of the coexistence of these two anomalies, even though it is accompanied only by meconium which issues by the urethral path. In the male, on rectal touch it is sometimes possible to palpate at the level of the posterior aspect of the prostate the irregularity which consitutes the rectal orifice of the fistula. Urethroscopy will permit actual visualization of the urethral orifice; however, urethrography is the ideal means of diagnosis, showing the localization, the length and caliber of the communicating duct between the rectum and the urethra.

The literature contains few references to similar cases. Mention is made of the publications by M. G. Motz and Hugh Young and of the book by Kerr and Gillies. Naturally, in all these patients with recto-urethral fistula, when the urinary opening occurs at the level of the prostatic urethra, cystoscopy will fail to demonstrate an abnormal communication between the rectum and the lower urinary tract. Two cases are reported by the authors.—*J. T. Case, M.D.*

Gynecology and Obstetrics

Mondor, Henri; Porcher, Pierre; Olivier, Claude; and Simon, Gaston-Claude. La radiographie dans les hémopéritones de la grossesse tubaire. (Roentgenography in hemoperitoneum of tubal pregnancy.) *Presse méd.*, Dec. 25, 1951, *59*, 1717–1720.

Clinical recognition of extrauterine pregnancy with hemoperitoneum ordinarily is not difficult. However, the diagnosis may not be apparent in less advanced or localized forms. In these, roentgen examination of the abdomen may be of some assistance by demonstrating pressure on and displacement of viscera by collections of blood, which usually are found between intestinal loops, under the diaphragm and in the parietocolic gutters. When the blood is in a fluid state, it changes position with the patient. Coagulated blood remains constant in position, usually in the pelvis and on the affected side. Five roentgenograms are ordinarily made, in the prone, supine, and each lateral decubitus.

The significant findings are: asymmetric pelvic opacity which is not sharply circumscribed; abdominal opacity which may be general or in the flanks; several hours after the accident there may be reflex ileocolic distention without or with fluid levels; rarely, extra-intestinal fluid levels may be seen. These latter have been shown clearly in 3 cases subjected to pneumoperitoneum.—*Marcy L. Sussman, M.D.*

Schmitz, Herbert E., Towne, Janet E., and Smith, Charles J. Role of surgery in the management of cervical carcinoma. *Radiology*, Dec., 1951, *57*, 826–831.

This is chiefly a consideration of the surgical indications and procedures in the management of cervical carcinoma. Irradiation is considered the basic method of treatment. Surgery is regarded as a necessary adjunct in some selected cases.

Cases of early cervical carcinoma classed as suitable for operative treatment are the following:

(1) Radioresistant cell types as proved by repeated biopsies, cytologic studies or clinical evidence during or after radiation therapy
(2) Complete prolapse of the uterus complicating Stage I and II (Schmitz classification)
(3) Pregnancy
(4) Refusal of radiation therapy by the patient.

Surgical procedures utilized in these early cases include Wertheim operation with pelvic lymphadenectomy as well as the Schauta hysterovaginectomy.

The justification for ultraradical surgery as a possible curative procedure for advanced cervical cancer is as yet undetermined. Radical surgical procedures are divided into three groups:

(1) Radical surgery indicated where the cervix appears healed but bladder invasion has been found on cystoscopy. This calls for a bilateral pelvic lymphadenectomy, hysterectomy, cystectomy, and transplantation of the ureters into the bowel or the skin.

(2) Radical surgery indicated where rectal invasion occurs with an apparently healed cervical cancer. Such procedure calls for bilateral pelvic lymphadenectomy, hysterectomy, and the abdominoperineal resection of the rectum and the vagina.

(3) Exenteration operation, which is the ultimate concept of ultraradical surgery, including bilateral pelvic lymphadenectomy, abdominoperineal resection of the bladder, vagina, and rectum, together with colostomy and transplantation of the ureters.—*A. W. Sommer, M.D.*

Genitourinary System

Riches, E. W., Griffiths, I. H., and Thackray, A. C. New growths of the kidney and ureter. *Brit. J. Urol.*, Dec., 1951, *23*, 297–356.

The authors have obtained data from 2,314 cases of neoplasm of the kidney and ureter, probably the largest series ever collected, and have made a complete statistical analysis of this material.

1. *Incidence and Symptoms.* Adenocarcinoma was the most common pathologic type and represented 75 per cent of the total number of cases. Eighty per cent of these cases occurred in the fifth, sixth and seventh decades. Hematuria was the most common symptom. It was noted in 62 per cent and was the sole presenting symptom in 21 per cent. Pain (50 per cent) and tumor (34 per cent) complete the classical triad of symptoms of renal tumor.

Tumors of the kidney pelvis, including transitional cell, squamous cell and simple papilloma occurred in 315 cases. This was 12.5 per cent of the entire group of neoplasms. Hematuria was present in 90 per cent of the pelvic tumors. It was the sole presenting symptom in 49 per cent and was associated with pain in another 40 per cent. A palpable tumor was detected in less than 2 per cent of neoplasms of the renal pelvis. Thirteen per cent of the squamous cell carcinomas had extended into the adjacent ureter, and extension to the ureter or bladder was found in 46 per cent of the transitional cell papillary type, indicating the advisability of investigation of both the upper and lower urinary tracts. The presence of renal calculi in 29 per cent of the squamous cell tumors of the pelvis suggests the possibility that calculi predispose to this type of malignant neoplasm.

Wilms' tumor was found in 189 cases, with nearly 50 per cent occurring between the ages of two and four years. In this group a palpable tumor was present in 68 per cent and was the only presenting symptom in 55 per cent. Hematuria was evident in 18 per cent, but was seldom the solitary presenting symptom.

Primary tumor of the ureter was recorded in only 21 cases, less than 1 per cent of the entire group. Hematuria was noted in 86 per cent of these cases and was associated with loin pain in 33 per cent.

2. *Diagnosis.* Cystoscopy, intravenous and retrograde pyelography, aortography and perirenal oxygen injection are the important diagnostic aids in the investigation for the presence of a renal tumor. Cystoscopic examination should be performed even in the presence of active bleeding to help localize the source of the hemorrhage.

Roentgenography is the most important diagnostic measure which was employed. A plain film of the abdomen occasionally demonstrates enlargement of the kidney or calcification in a tumor. Intravenous pyelography should be done in every suspected renal tumor to determine the kidney function and to demonstrate calyceal abnormalities. Intravenous pyelography was done in 934 of the 1,746 cases of adenocarcinoma which were studied. Retrograde pyelography should be employed to visualize the internal structure of the kidney when kidney function is absent and to adequately demonstrate calyceal or pelvic deformity. A cortical tumor usually produces major changes in the calyces such as compression, obliteration, displacement, elongation and dilatation.

Aortography may be helpful in differentiating between a solid neoplasm and a cyst. Perirenal oxygen injection frequently shows fixation of the kidney. Both aortography and perirenal injection may be used in conjunction with intravenous and retrograde pyelography.

3. *Survival and the Factors Which Influence It.* In adenocarcinoma of the kidney free of distant metastases, nephrectomy is the indicated treatment. In patients under the age of fifty, there was a survival rate of 35 per cent; over fifty, the survival rate was 20 per cent. The presence of renal vein involvement resulted in a 50 per cent decrease in the survival rate. The combination of surgery and roentgen therapy was employed in a small number of cases and produced a definite increase in the survival rate.

Tumors of the renal pelvis are best treated by

nephro-ureterectomy. Fifty-two cases of transitional cell carcinoma showed a 33 per cent five year survival when the ureter or bladder was involved and a 38 per cent five year survival rate when these structures were uninvolved. None of the patients with squamous cell carcinoma survived five years, while 50 per cent of 61 cases of simple papilloma treated by nephrectomy were alive at the end of five years.

Wilms' tumors were treated by surgery and by a combination of surgery and roentgen therapy. It is concluded that small tumors should be treated by nephrectomy alone and should be followed by roentgen therapy if there is microscopic or macroscopic evidence of incomplete removal. Large tumors which are considered clinically inoperable should have preoperative irradiation, followed in three weeks by nephrectomy and postoperative irradiation. Localized bony metastases are not contraindications to nephrectomy, but cases with pulmonary metastases should be considered inoperable.

4. *Conclusions.* The study of this large series of cases has emphasized the importance of accuracy in diagnosis and has demonstrated the improvement in the results obtained in the treatment of adenocarcinoma by the use of postoperative roentgen therapy. The most important prognostic factor is the histopathologic grading of the tumor; in adenocarcinoma, invasion of the renal vein is more probable if the growth is of high malignancy and in transitional cell tumors of the pelvis, the survival rate depends to a large extent on the histopathological degree of malignancy.—*Gerald Lavner, M.D.*

White, Matthew. Renal tumours in children. *Brit. J. Urol.*, Dec., 1951, *23*, 357–358.

The author gives a brief summary of the results of treatment in 51 children admitted to the Royal Hospital for Sick Children, Glasgow during the period 1920–1950, with tumors involving the kidney and ureter. Of 38 of the tumors identified by histopathologic examination, 28 were reported as nephroblastoma, 7 as sympathicoblastoma, 2 as mixed cell sarcoma, and 1 as carcinoma.

The most common complaint was rapidly developing abdominal swelling. Hematuria was the presenting symptom in only 6 cases and all of these died within a few months after laparotomy.

Four five year survivals are reported. Two of these received postoperative roentgen therapy and 2 others, surviving twenty-three and fourteen years respectively, did not receive roentgen therapy.—*J. F. Martin, M.D.*

Brown, J. J. Mason. Nephroblastoma. *Brit. J. Urol.*, Dec., 1951, *23*, 358–360.

The author describes his experience in treating 13 patients with nephroblastoma (Wilms' tumor). The ages varied from eight months to eight years. The tumor involved the right kidney in 9 cases and the left in 4 cases.

The presenting symptoms were: abdominal swelling, 6 cases; abdominal pain, 2 cases; vomiting, 2 cases; hematuria, 2 cases; limb pains, 1 case. In 12 of the 13 patients, the tumor was large and readily palpable.

The clinical studies are reviewed and a chart illustrating the treatment and result is presented.—*J. F. Martin, M.D.*

Charteris, Alexander A. Radiotherapy in the treatment of kidney tumours. *Brit. J. Urol.*, Dec., 1951, *23*, 361–363.

This paper is an assessment of the value of radiation therapy in the treatment of renal tumors. The material consists of 58 cases, 12 of whom were children.

Wilms' Tumor: The experience with 12 cases is reported. There were 2 five year survivals and both had received roentgen therapy after nephrectomy.

Renal Carcinoma: This group includes 45 cases. Fifteen cases were treated by roentgen therapy alone. Most died of the disease within two years, but 2 survived for two years and 1 for thirteen years. Eight cases were treated for recurrence after surgery alone and none have survived. Twenty-two patients were treated with surgery and postoperative roentgen therapy and, of these, 7 have survived for periods of eleven (2 cases), seven, six, five and a half and three and a half years (2 cases). In comparison, 29 patients were treated by nephrectomy alone and 8 survivals were listed.

The roentgen therapeutic aim is a tumor dose of 4,000 r in four weeks, given with 200-250 kv. and 2 mm. Cu filter.

The series of cases presented suggests that better results may be obtained when roentgen therapy is employed in addition to nephrectomy.—*J. F. Martin, M.D.*

Walsh, Anthony. Solitary cyst of the kidney and its relationship to renal tumour. *Brit. J. Urol.*, Dec., 1951, *23*, 377–379.

Solitary cyst of the kidney is found in 3 to 5 per cent of all autopsies. The coincidental finding of two lesions of the kidney may be expected to be noted occasionally because of the relative frequency of kidney tumors. The author's analysis of the reports of over 500 cases of cystic disease showed the presence of both a solitary cyst and a malignant tumor in 7 per cent of the cases. This incidence rose to about 30 per cent when the contents of the cyst were hemorrhagic. This is a much closer relationship than can be explained by mere coincidence.

Of the many theories of the etiology of a solitary renal cyst, Helper's hypothesis of tubular blockage associated with ischemia in the same part of the kidney is convincing and explains the frequent association of solitary cyst and neoplasm.

There are no characteristic clinical or roentgeno-

logical features of a solitary renal cyst and a definite preoperative diagnosis cannot be made with certainty. The frequent association of cyst and malignant neoplasm demands surgical exploration of every apparent solitary cyst of the kidney.—*Gerald Lavner, M.D.*

WILLIAMS, D. INNES. The foetal ureter. *Brit. J. Urol.*, Dec., 1951, *23*, 366–371.

It has been stated that the fetal ureter in the latter part of fetal life shows a physiological dilatation in the lumbar and pelvic regions which may persist and cause congenital hydroureter.

The author has dissected and made observations of serial sections of the ureter in intact embryos. The ureter was found to be a straight tube of relatively uniform caliber up to the fourth month of fetal life. Later there was differentiation into pelvic, lumbar and isthmal segments. The lumbar segment is spindle shaped but none of the segments showed dilatation in serial sections. Segmentation is considered to represent an exaggeration of normal variation in caliber and is not of neuromuscular origin or due to ureteral torsion.

This segmentation of the ureter is related to the pathological dilatation which occurs in childhood. The ureter is a relatively rigid structure in the adult and increased intraureteral pressure is transmitted to the more easily distensible renal pelvis. In childhood, the ureter dilates readily and increased pressure manifests itself in two distinct patterns, dilatation of the pelvic segment and dilatation of the lumbar segment.

Dilatation of the pelvic segment results from obstruction to the bladder outlet, obstruction to the lower end of the ureter or from vesicoureteral reflux. The dilatation is slowly retrogressive in nature, beginning in the lower ureter and extending proximally to involve the entire ureter. In childhood, hydroureter without hydronephrosis is the end result of the slow progression of ureteral obstruction or reflux starting early in life. This process may be arrested at any stage and in the adult may be recognized as hydroureter without hydronephrosis.

Dilatation of the lumbar segment is seen in childhood as a result of chronic urinary infection, in recurring urinary infections and associated with pelvic calculi and septic hydronephrosis. The dilatation is not due to obstruction but rather to the atonicity of the muscle, resulting from the toxic effect of infection. The ureteral changes which accompany pregnancy are produced by relaxation of the muscle of the lumbar segment as a result of hormonal influence.

In conclusion, the ureter in the fetus is not dilated. It has a segmental pattern which is more evident in the fetus than after birth and is more evident in the pathological state than in the normal organ.—*Gerald Lavner, M.D.*

LLOYD, FREDERICK A., and PRANKE, DON. Patent urachus. *Urol. & Cutan. Rev.*, Dec., 1951, *55*, 734–738.

Contrary to the usual belief, the urachus is not derived from the allantois but from the ventral cloaca. It is a cone-shaped structure in the adult, measuring 5.5 cm. in length, and its lumen remains patent throughout life, although it may be plugged by masses of desquamated epithelial cells.

Patent urachus is more common in the male than in the female, and symptoms of urinary fistula through the umbilicus may develop as the result of urethral stricture or vesical neck obstruction from prostatic hypertrophy. Cysts of the urachus usually appear in its lower third. Small cysts are common; larger ones are rare. Frequently, these cysts become infected and a pyo-urachus results. Occasional cases of stone formation, tuberculosis, and carcinoma of the urachus have been reported.

This article includes a report of 3 patients with patent urachus who were treated by surgical excision with good results. The demonstration of cysts of the urachus may be aided by opaque or nonopaque cystograms.—*G. W. Chamberlin, M.D.*

BLUM, E., WITZ, J., and GANDAR, R. L'aortographie en série dans les affections chirurgicales du rein. (Serial aortography in surgical diseases of the kidney.) *J. d'urol.*, 1951, *57*, 387–404.

The authors have used their angiocardiographic equipment for serial lumbar aortography, employing 40 cc. of a 70 per cent diodone solution. The first exposure is made after injection of 15 cc. of the medium, followed by five exposures at intervals of one second.

The technique of injection is recorded, and the equipment, built according to directions given by Dr. Welsch, radiologist of the hospital, is described in detail.

The authors have been impressed with the value of aortography in the differential diagnosis of arterial hypertension. They report 7 cases, showing that angiographic study of the renal circulation proved helpful in directing treatment, by permitting them to distinguish between unilateral and bilateral functional impairment, renal and extrarenal disease, tumors and vascular anomalies, and the like. The method has revealed the distribution of the renal vessels in the individual case, the rate of passage of the opaque medium through the intrarenal vascular bed, and occasionally the presence of abnormalities of other than renal origin. The authors agree with and quote the opinion of A. K. Doss, to the effect that no examination for unexplained hypertension can be considered complete without lumbar aortography. They find this method particularly valuable

when intravenous urography gives equivocal results and retrograde pyelography cannot be performed.

This concise and well documented presentation adds to the usefulness of abdominal aortography.—*Albert Oppenheimer, M.D.*

Kretschmer, Herman L. Genito-urinary tuberculosis. *Urol. & Cutan. Rev.*, Dec., 1951, *55*, 715–724.

The present day incidence of genitourinary tuberculosis is considerably reduced over the past years because of the availability of pure milk, educational campaigns in the field of tuberculosis, mass chest surveys by roentgen methods, and early diagnosis and treatment of pulmonary tuberculosis.

Tuberculosis of the Kidney. Tuberculosis of the kidney is thought to be hematogenous in origin from a primary focus elsewhere in the body. Most of the cases of this disease occur between the ages of twenty and fifty. In one of the author's series of cases, he noted that the disease was bilateral in 23 per cent. The tubercle bacillus is more prone to be fixed in the medullary portion of the kidney or the corticomedullary zone at the base of the renal pyramids. In this area proliferation and necrosis occurs with ulceration involving a calyx. From such a focus the spread in the kidney can be in the urinary tubules or by way of the vascular system or lymphatics. In addition, the disease tends to spread to the ureter and urinary bladder. Renal tuberculosis rarely causes symptoms, but the involvement of the ureter and bladder may produce the earliest evidence of the disease. The diagnosis is based upon the demonstration of the tubercle bacillus in the urine, the localization of the lesion by roentgen examination, and the cystoscopic study of the bladder and ureteral orifice. In unilateral renal tuberculosis the treatment is nephrectomy as early as possible. In most cases of bilateral renal tuberculosis, nephrectomy is not indicated. The postoperative course in those cases which have extensive bladder involvement and persistence of bladder symptoms constitutes a serious problem. However, in the cases which have the benefit of early nephrectomy before there is extensive involvement of the bladder this is not a major problem.

Genital Tuberculosis in the Male. This means infection by the tubercle bacillus of one or more portions of the genital tract, consisting of the epididymis, testicle, vas deferens, seminal vesicles, and prostate. The incidence is usually highest between the ages of twenty and forty. Gonorrhea and trauma are not considered as serious etiological factors, except as they may light up a late tuberculous infection. The onset of genital tuberculosis is usually slow and insidious. This makes it difficult to determine just when the disease started; it may be present for a long time before it produces symptoms. Epididymitis in the early cases is usually unilateral and in a large number of instances it tends to become bilateral if untreated. Symptoms of genitourinary tuberculosis include frequency, burning, hematuria, dysuria, and backache. The treatment of genital tuberculosis is the removal of the disease as soon as possible. Such an operation can usually be performed under local anesthesia and even in the presence of advanced disease elsewhere is without great surgical hazard. The conservative operation which is most frequently carried out in this country consists of removal of the epididymis and vas deferens. Most surgeons and urologists feel that the removal of the seminal vesicles, part of the prostate, the vas deferens, and both epididymides is not necessary.

A footnote on page one of this article notes with regret the death of Dr. Herman L. Kretschmer.—*G. W. Chamberlin, M.D.*

Nervous System

Luce, James C., Leith, W., and Burrage, Walter S. Pantopaque meningitis due to hypersensitivity. *Radiology*, Dec., 1951, *57*, 878–881.

Pantopaque (ethyl iodophenylundecylate) is a contrast medium which is widely used in the study of lesions in and about the spinal canal. Use has shown it to be a relatively safe but not entirely innocuous substance. Evidence has been plentiful that it causes an inflammatory and proliferative meningeal reaction occasionally when used intrathecally. Immediate but transient systemic reactions occur such as mild fever, headache, malaise, and cerebrospinal fluid changes, but these have not been considered contraindications to continued use of this medium.

The authors present 2 cases which showed evidence of meningeal reaction to the intrathecal injection of pantopaque. This reaction was delayed in onset and associated with certain phenomena which strongly suggested hypersensitivity. These patients had been skin tested with 0.1 ml. of pantopaque injected intradermally and had had negative readings twenty minutes later. The delayed meningeal reactions were accompanied by flare-ups at the original skin test sites and occurred approximately ten and thirty days after the myelography. Of significance was the fact that both of these patients gave a personal history of atopic ragweed hay fever, confirmed by positive ragweed skin and passive transfer tests.

The authors feel that since the skin test with pantopaque has not been shown to have any usefulness in preventing the commoner type of reaction to myelography and since in occasional individuals it appears to be an effective sensitizer, its use in association with myelography appears to be contraindicated.—*D. N. Dysart, M.D.*

SKELETAL SYSTEM

MUCCHI, L., and COLUMELLA, F. Arteriography in diseases of bone. *J. Faculty of Radiologists*, Oct., 1951, *3*, 135–146.

Arteriography in bone pathology is presented as an absolutely safe method of investigation, provided the correct technique is employed. Intra-arterial injections are performed percutaneously under a local anesthetic, either in the direction of or against the blood flow. The authors prefer pielosil or umbradil because of better patient tolerance. This type of examination facilitates the differentiation between benign and malignant bone lesions. The appearances in malignant tumors are so characteristic and clear-cut as not to require the confirmation of the diagnosis by biopsy. In such tumors there is a pathological circulation with obvious signs of malignancy, characterized by (a) increased regional circulation; (b) a rich vascular plexus, with vessels abnormal both in size and distribution; (c) large vascular spaces in the tumor mass, appearing as irregular spots and streaks of the opaque material; (d) the presence of nontraumatic arteriovenous fistulae, causing a great speeding-up of the circulation in the tumor; (e) the diffusion, characteristic and constantly present, of opaque substance more or less densely and regularly throughout the tumor mass, resulting in the whole extent of the neoplastic changes appearing more opaque than normal bone; (f) in relatively early cases, an area of circulation, shown by small vessels, in the shape of an isosceles triangle of which the base is the zone of osteolysis and the apex is in contact with the end of a pre-existing artery which is markedly enlarged in caliber, the so-called "vascular paintbrush."

In subacute and chronic osteomyelitis, there is a slight arteriolar and venous vasodilatation, with slight slowing of the circulation. In tuberculous osteomyelitis and osteoarthritis there is a great diminution in the blood supply, both in the diseased tissues and in the whole area, together with a marked slowing of the circulation in the affected part. Generally in syphilitic gummatous osteitis and osteoarthritis, there is also a considerable diminution in blood supply, but in the nongummatous and ulcerative types of syphilis of bone, a considerable increase in the circulation is demonstrable.

In Paget's disease and in generalized osteitis fibrosa there is an increase in the vascular supply with acceleration of the circulation rate. In rickets and in Kienböck's disease essentially normal circulation was found.—*Samuel G. Henderson, M.D.*

HECKMAN, JAMES A. Ollier's disease. *Arch. Surg.*, Dec., 1951, *63*, 861–865.

Ollier's disease is called a multiple enchondromatosis and is actually a dyschondroplasia due to developmental error in endochondral ossification.

Lesions have a tendency to be unilateral with involvement of one bone or several bones of one extremity. The two lower limbs may be affected and only rarely are all four extremities involved. The most common site is in the metaphyseal region of long bones; however, the pelvis is also a favorite site. The skull, sternum and ribs are only rarely involved.

Shortening and deformity of the involved long bones are characteristic. Blood calcium, phosphorus and phosphatase are normal.

The author reports a classical example of Ollier's disease with unilateral development of multiple enchondromas in the metaphyseal regions of the long bones of one extremity as well as a lesion in the pelvis. Deformity and shortening were present and amputation was carried out.—*C. P. Truog, M.D.*

ROSENBLUM, JACOB, and GREENBERG, BERNARD. Infantile cortical hyperostosis (Caffey-Smyth syndrome). *A.M.A. Am. J. Dis. Child.*, Dec., 1951, *82*, 710–716.

Two cases of infantile cortical hyperostosis are reported in this paper. The symptoms in both patients began before they were three months of age. They presented the typical bone involvement and characteristic facial appearance. The clavicles and ribs frequently show bilateral involvement but the scapula is usually unilaterally involved. In the second patient reported in this paper, however, bilateral involvement of the scapula was found.

The mandibular involvement gives the syndrome the characteristic facial appearance which permits one to make the diagnosis on first appearance. The authors state that absence of mandibular involvement in patients with the onset after eleven months would indicate that these are cases of hypervitaminosis A rather than infantile cortical hyperostosis. They state that Caffey in his first paper questioned whether such cases were the same disease and is now convinced that the conditions in older children are unrelated to the disease in young infants.—*R. S. Bromer, M.D.*

HANCOX, N. M., HAY, J. D., HOLDEN, W. S., MOSS, P. D., and WHITEHEAD, A. S. The radiological "double contour" effect in the long bones of newly born infants. *Arch. Dis. Childhood*, Dec., 1951, *26*, 543–548.

One hundred and seventeen infants, of whom the majority were premature, born in the Mill Road Maternity Hospital, Liverpool, have been studied, 97 during life and 20 after death. Of the living infants, 73 were regarded as healthy, 62 being premature, with birth weights of 5 lb. 8 oz. or less, and 11 mature. Twenty-four were abnormal on account of congenital defects or acquired disease.

The double contour effect is a normal roentgeno-

logical finding in the long bones of some newborn infants. The cause is shown histologically to be due to a local exaggeration of the normal appositional growth of bone. The effect is visualized best and most frequently in the younger infants, particularly the premature ones. Its appearance is not related to any known type of disease and its presence in association with other diseases must be regarded as being entirely fortuitous.—*J. J. McCort, M.D.*

Collier, Fred C., Reich, Alfred, and King, John W. Multiple myeloma; a report of four cases demonstrating Bence-Jones proteinemia found during routine complement-fixation tests. *New England J. Med.*, Dec. 20 1951, *245*, 969–971.

The authors call attention to the fact that at the Cleveland Clinic in the course of doing routine complement-fixation tests, sufficient Bence-Jones protein was present in the blood serum to produce a visible precipitate when the serum was heated to 56°C. This rare phenomenon was noted in 4 cases out of more than 700,000 complement fixation studies in the serology laboratory. All 4 of the cases were later found to have multiple myeloma.

During the same period of time, 162 cases of multiple myeloma have been studied, but the Bence-Jones precipitation was noted only 4 times. It is significant that, when noted, this finding is extremely specific. When the protein cannot be demonstrated in the serum in this manner, it can be demonstrated in the urine in about 65 per cent of persons with multiple myelona.—*C. L. Hinkel, M.D.*

Sirry, Aly. The pseudo-cystic triangle in the normal os calcis. *Acta radiol.*, Dec., 1951, *36*, 516–520.

Lateral roentgenograms of 1,200 calcanea revealed, near the center of the bone, a triangular translucent area which was strikingly well defined in 7.1 per cent of the cases, moderately well defined in 22.1 per cent and faintly seen in 70.8 per cent.

This area of decreased density proved to be an area of normal bone with a special lamellar arrangement of the spongiosa due to muscular and fibrous lines of force.

The differentiation of such an area from a solitary bone cyst can be made by bearing in mind that the latter appears as a clear, translucent and not necessarily round or triangular area in the bone with thinning and expansion of the surrounding cortex; if large, it is usually multilocular as revealed by the presence of septa.

Other differential diagnoses include: (1) fibrosis of bone; the cortex of the bone is usually thinned or expanded in this condition; (2) osteitis deformans; the trabeculations are coarse and there may be symptoms in Paget's disease; (3) medullary enchondroma, in which bone lamellation is not normal and there is usually liquefaction of bone; (4) arthritic cysts which lie in relation to the joint space; (5) hydatid cysts; there is evidence of caseous debris, soft tissue change and possibly fracture, in this type of cyst; (6) chronic fibrous osteomyelitis which shows a reactive capsule of bone sclerosis surrounding the area of bone translucency.—*Mary Frances Vastine, M.D.*

Nisson-Lie, H. S. Pseudoarthroses of the humerus. *Acta orthop. Scandinav.*, 1951, *21*, 22–31.

Whether a fracture will heal within a reasonable time depends to a considerable degree on the treatment. Bad fixation or fixation for too brief a period may lead to pseudoarthrosis, but too strong traction is a more frequent cause. It may also occur after unsuccessful operative treatment due to infection or improper fixation.

Transverse fractures or short oblique fractures are often difficult to unite. The reason is partly due to the fact that the fragments are difficult to immobilize, and partly that they are easily overextended. Rotation at the site of the fracture plays an important part.

Pseudoarthroses are seen relatively often in the upper arm. The author warns against extension treatment in transverse fractures and states that they ought to be fixed in an abduction plaster cast. Often operative fixation is necessary.

In fibrous pseudoarthroses, Z-shaped resection will fuse the bone quickly. In pseudoarthroses with bone defects, intramedullary nailing with cancellous bone graft is the best method, with the arm held in abduction plaster for two to three months. He refers to 9 cases of humerus pseudoarthroses in which osseous healing occurred in two to three months after the operation.—*R. K. Arbuckle, M.D.*

Gil y Gil. Le rôle du tissu osseux spongieux dans la dissémination neoplasique. (The role of the spongy osseous tissue in neoplastic dissemination.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1951, *32*, 573–576.

Batson demonstrated the existence of a prevertebral venous plexus which communicates with the cephalic sinus and the pelvic venous plexus, thereby forming an independent venous system. Certain neoplasms, as, for example, carcinoma of the prostate, are known to produce metastases to the bone through the intermediary of this venous system without invading the general circulation. The author believes that the pelvic venous plexus is also responsible for the dissemination of carcinomas originating within the pelvis to the osseous structures of the pelvic girdle, although the metastatic foci, being of the osteolytic type, are more difficult to detect than the osteoblastic lesions of carcinoma of the prostate.

It is conceivable that a similar dissemination occurs in carcinoma of the breast. The veins of the mammary gland as well as those of the superficial and deep layers of the chest wall carry the neoplastic cells via the intercostal veins either directly or through the intermediary of the internal part of the mammary gland to the spongy bone of the sternum. The metastatic lesions of the sternum in turn discharge neoplastic cells into the venous circulation intercommunicating with the prevertebral venous plexus, thus causing spreading through the spongy tissue of the vertebral column and hence through the spongy tissue of the pelvic girdle, ischia and upper epiphyses of the femora. At the other end of the prevertebral venous plexus, ascending dissemination leads to involvement of the cranial bones.

In accepting this concept of the role of the spongy osseous tissue in neoplastic dissemiation, it becomes evident that in dealing with carcinoma of the breast accurate examination of the sternal bone is important. The author employs three methods for this purpose which are:

(a) *Roentgenography of the sternum.* Many techniques have been suggested for the roentgen examination of the sternum but the author found the following procedure most useful: The patient is placed preferably in left lateral decubitus and rotated slightly forward so that the sagittal plane of the body forms an angle of 20 to 25 degrees with the vertical plane. The left upper extremity rests on the side behind the patient's back, whereas the right arm is raised above the head, the right hand being put behind the occiput. The head is placed in forced extension on a pillow. The left breast, when pendulous, is pushed backward. The right thigh is flexed in the hip joint and brought slightly foward. The anterior part of the tilted pelvis is supported by sand bags. The cassette is placed under the patient. The central ray is directed perpendicularly between the anterior and posterior axillary lines at the level of second or third intercostal space and the exposure is made at 1 meter focus-film distance.

(b) *Gil-Gil sign.* The author has described this sign many years ago and the First Lusitanian Spanish Congress has attached his name to it in his honor. It is a clinical sign, consisting of localized pain under the pressing finger. Before every roentgenographic examination of the sternum, an attempt is made to elicit this sign. It usually indicates the presence of an area of destruction and the central ray is then directed through this area.

(c) *Sternal puncture.* This is performed routinely in all cases of carcinoma of the breast. The demonstration of malignant neoplastic cells usually helps to confirm the diagnosis of metastasis.

The author uses the Steinthal method of classification into three stages for the clinical gauging of carcinomas of the breast. Surprisingly, in several of the Stage 1 cases a metastatic invasion of the sternum was found when the malignant neoplasm clinically appeared local. In patients with carcinoma of Stages II and III the incidence was much higher.

The early demonstration of sternal involvement in carcinoma of the breast is of fundamental importance since it may permit successful treatment of a focus most likely to lead to hematogenous dissemination. The author prefers radium therapy in the form of surface molds for this purpose.—*T. Leucutia, M.D.*

Brason, Frederick W., Eschner, Edward G., Sanes, Samuel, and Milkey, Gustave. Secondary carcinoma of the phalanges. *Radiology*, Dec., 1951, *57*, 864–867.

Two cases of secondary carcinoma of the phalanges in the hand are reported. The first case is that of a squamous cell carcinoma of the nail bed following a four month previous crushing injury to the region. The second case demonstrates a metastatic lesion from a carcinoma of the lung with destruction of two-thirds of the distal phalanx of the hand.

Roentgenograms demonstrating the invasive and destructive nature of the lesions and photomicrographs depicting their histopathological character are included.

The authors comment that secondary carcinoma of the phalanges is uncommon. In most instances the metastases involve the phalanges of the hand. The metastatic lesion usually presents itself as an inflammatory process with pain, swelling, redness, tenderness and pulsation. The roentgenogram consistently shows bony destruction, occasionally with soft tissue changes.—*E. E. Seedorf, M.D.*

Wassmann, K. Kyphosis juvenilis Scheuermann—an occupational disorder. *Acta orthop. Scandinav.*, 1951, *21*, 65–74.

According to Scheuermann's view, this is a disease which occurs in young, not full-grown individuals, in particular after heavy weight-bearing, appearing in the form of a kyphosis which soon becomes fixed, most frequently in the lower thoracic column. Roentgen examination reveals irregularities around the marginal crest of one or a few vertebrae, wedge-shaped vertebral bodies and irregular waving of their articular surfaces.

The disease is one chiefly affecting the male. The etiology is unknown.

The author estimates the frequency of the disease among Danish males to be from 4 to 5 per cent based on the reports from the Danish Army recruit examinations comprising about 581,000 men.

The disorder is found to be eight times as frequent in the country as in other communities. In 23 out of 24 cases, trauma caused by the patient's work could be demonstrated at the onset of the disorder, 18 of these patients being employed in agricultural work and 5 in other hard physical labor. He believes it justifiable to term Scheuermann's disease an occupational disease, if we establish a causal con-

nection with the special conditions of work in agriculture where the boys, often before their tenth year and as a rule at the age of about fourteen or fifteen years, have to take part in physical labor which is far harder than their osseous system, and in particular their vertebral column, can cope with. In only 1 instance did the recruit perform no physical labor and this seemed to be a case of hereditary determination. There was no evidence of rachitic signs among the patients with Scheuermann's disease.

The author concludes that the principal cause of Scheuermann's kyphosis juvenilis is hard physical labor during the youthful years. A hereditary predisposition can be determined in a few cases. Defective carriage, such as sway-back, may be a predisposing factor.—*R. K. Arbuckle, M.D.*

Schmuñis, M. Espondilosis cervical, síndrome de Barre-Lieou. (Cervical spondylosis; syndrome of Barre-Lieou.) *Semana méd.*, Dec. 13, 1951, *99*, 1123–1126.

Cervical spondylosis is the arthrosis of the spine next in frequency to lumbar spinal arthrosis. It is usually the result of "use or wasting." The lower cervical vertebrae are most frequently involved. Trauma, severe effort and irritation may play a role in causation, and the condition may occur as early as the third decade of life. It is more frequent in females. Infection may play a role in some cases, including brucellosis.

The basic anatomopathologic lesion is degeneration of the intervertebral disc, especially in its peripheral portion. Osteophyte formation and herniation of the nucleus pulposus may occur. Symptoms include pain of segmental distribution, headache, neck pains, and feelings of discomfort. Irritation of posterior cervical sympathetic nerves may lead to dysphagia, the syndrome of Barre-Lieou. Attention is also attracted by shoulder pain, weighty sensation in shoulders or arms and formication.

Treatment consists of exercises, local novocain injections, short wave, infrared and roentgentherapy. —*Charles M. Nice, M.D.*

Felländer, Max. Early cases of spondylarthritis anchylopoetica. *Acta orthop. Scandinav.*, 1951, *21*, 55–64.

The early symptoms of ankylopoetic spondylarthritis are diffuse. They usually appear in the form of attacks of pain, of myalgic or radicular type; the pain may move from one region to another with pain-free intervals. Many cases are misjudged and diagnosed as myalgia, rheumatism, growing pains and fibrositis.

Twenty-two cases showing early roentgen changes in the sacroiliac joints were selected for follow-up studies. All were men between nineteen and forty-two years of age, with the average being thirty-one years. The symptoms made their appearance between the ages of fourteen and forty-two, the average being twenty-six years. The duration of the disease at the first examination was seven to sixteen years, with an average of eleven years. The period of observation was four to eleven years, with an average of seven years.

Prespondylitic signs occurred in 9 cases. It was not possible to provoke pain by means of the various methods employed to test the sacroiliac joints. Of the 22 cases re-examined, 10 had developed typical spondylarthritis both clinically and roentgenologically, with stiff back, calcification of the ligaments and eventual ankylosis in the intervertebral joints. Three had clinically advanced disease but showed roentgen changes in the sacroiliac joints only. The remaining 9 cases had not progressed, and the whole back had normal mobility. The progression was independent of the observation time and duration of the symptoms.

Conclusions drawn from the sedimentation rate, with respect to the activity of the disease, are apparently unreliable. The roentgen changes in the sacroiliac joints are typical. The surface contours of the joints are initially somewhat blurred. Later on, the joint fissure becomes narrow, erosions appear on the joint surfaces and sclerosis develops juxtaarticularly. Finally, the joint tends to disappear more and more and the last stage is osseous ankylosis. There was no certain parallelism between the clinical degree of severity and the type of roentgen changes.—*R. K. Arbuckle, M.D.*

Brodin, Harald. Resection of the knee-joint in tuberculosis re-examination of 369 cases. *Acta orthop. Scandinav.*, 1951, *21*, 155–186.

The author analyzed 369 resected cases of tuberculosis of the knee joint from information obtained by questionnaires sent to former patients of the Coast Sanatorium of Apelviken in Sweden. Only 2 cases received chemotherapy in this series. Those patients in whom ankylosis was not observed before leaving the hospital were requested to have roentgenograms made of their knees and forwarded to the author.

Preoperative roentgenographic classification was based essentially on principles used by Mortens. Those cases in which foci were seen in the bone at the periphery of slightly involved or uninvolved articular surfaces were said to show "marginal destruction"; those exhibiting slight erosion of the articular surfaces were classified as "surface destruction"; and those disclosing deep lesions of the joints were classified as "deep destruction." Marginal destruction was seen in 135 cases, superficial destruction in 93, deep destruction in 137 and no destruction except decalcification in 4.

The knee was resected in all adult cases of tuberculosis of the knee except in synovitis when the process was in the healing stage, when the patient's

condition was poor or if there were many fistulae. Children were seldom operated upon and then only when the epiphyseal lines would not be damaged.

The knee joint, following resection, was preferably fixed in 5 degrees flexion and 0 to 5 degrees valgus position. Ankylosis was said to be present when distinct bridging trabeculae were seen. Ankylosis occurred on the average in about five and one-half to six months. Postoperative ankylosis was obtained roentgenographically in 83 per cent and 15 per cent reported a stiff knee. Pseudarthrosis developed in 3 cases and in 1 there was still some mobility after arthroplasty. Three cases were still undergoing treatment.

Complications occurred in 49.6 per cent of the cases with fistulae present in 33.5 per cent. Other complications were pleuritis, abscess, shock, necrosis, hematoma, exacerbation of the pulmonary tuberculosis, etc. Complications increased in connection with multiple tuberculosis, tuberculous abscesses in the knee joint, increased sedimentation rate before operation, fistulae before operation and a history of the disease for less than two years before operation. Old age, short treatment time before operation and marked roentgenological changes had no apparent effect on the incidence of complications.

Mortality from tuberculosis after leaving the hospital was greater among the patients with multiple tuberculosis than those with only the knee joint involved. The author's findings compared favorably with those obtained by Toumey, Sorrel, Blauel and Mortens.

Six excellent roentgenograms are presented showing "deep destruction" of the knee joint which, following surgical resection, progressed to firm ankylosis.—*Charles W. Cooley, M.D.*

Kollberg, Gösta. An unusual case of tuberculosis of the knee joint. *Acta orthop. Scandinav.*, 1951, *21*, 228–236.

The author presents a case of tuberculosis of the knee in a two and one-half year old boy who had widespread destruction affecting the joint. The patient was followed for eight years and the joint healed with complete function. The knee was in a cast for two and one-half years. The patient, at the eight year check-up, had full motion, well constructed bone architecture and no subjective symptoms. The involved extremity was 2 cm. shorter than the normal one and the soft tissue showed some atroply.

The patient's father had pulmonary tuberculosis and the the patient had hilar adenopathy which was thought to be tuberculous.

A series of excellent roentgenograms are presented: at the onset of the disease in 1940 no bone destruction was noted; in 1941, when the destruction was at its peak, the epiphysis was partially destroyed on its medial side; in 1944 repair was taking place; and in 1950 almost normal architecture was seen.

The two types of tuberculous involvement of the knee are discussed. In the synovial type, the synovial membrane is infected from the blood stream and the infection is at first limited. When only the synovialis and articular cartilage have been involved the process may heal. In the osseous type the infection originates from a focus in one of the epiphyses. When this focus opens through the articular cartilage into the joint, the infection spreads continuously causing new destructive areas. The mechanical status of the joint may be affected due to the destruction.

Some cases of synovial tuberculosis may recover with full range of motion. In osseous tuberculosis of the knee, recovery with full range of motion is considered almost impossible. Even recovery with 60° to 90° flexion is rare.

The author believes the simplest explanation of the favorable result in his case is that, in spite of the widespread destruction, the articular cartilage somehow resisted infection and remained viable.

The author expects that with the introduction of certain antibiotics, which have been proved to have a favorable effect on tuberculosis, cases with an equally favorable recovery will become more common.—*Charles W. Cooley, M.D.*

Blood and Lymph System

Boulvin, R., Chevalier, M., Gallus, P., and Nagel, M. La portographie par voie splénique transpariétale (note préliminaire). (Portography by means of transparietal splenic puncture; preliminary communication.) *Acta chir. belg.*, Nov., 1951, *50*, 534–544.

Visualization of the portal venous system and measurement of the blood pressure in the portal vein and its branches during laparotomy was described previously by several authors. It was found useful in cases of portal hypertension, mainly of extrahepatic origin, revealing the site and cause of the obstruction of the portal circulation.

The indications for the various surgical procedures aimed at relieving the portal hypertension could thus be more precisely established.

Abeatici and Campi visualized the portal venous system by transparietal puncture of the spleen in experimental animals and injection of diodrast into the splenic parenchyma. Léger demonstrated a portal venogram obtained by intrasplenic injection of diodrast after laparotomy. Later, he succeeded in injecting the contrast medium into the spleen by the transparietal route in 2 patients, without ill effects. De Sousa Pereira presented a similar case.

The authors describe their technique in detail and present 2 cases of portal hypertension, in both of which they carried out transparietal portal venography without complications, in 1 of the patients twice. In 1 case, the roentgenograms revealed narrowing of the intrahepatic branches caused by atrophic liver cirrhosis, confirmed by autopsy. In the

other, a compression of the splenic vein, probably due to lymph node metastases from a carcinoma of the pyloric region, diagnosed previously, was shown.

The injection into the spleen of 15 to 25 cc. of 70 per cent diodrast at body temperature is carried out under fluoroscopic control and several spot roentgenograms are taken at the shortest possible intervals. Two portal venograms accompanied by drawings are presented.

This new technique is of considerable interest as it seems to be without danger and enables the surgeon to visualize preoperatively the portal vein and its main branches and, by establishing the site of the obstruction, to plan the appropriate surgical procedure for relief of the portal hypertension (portocaval or splenorenal anastomosis).—*Karol E. Matzinger, M.D.*

Boulvin, R., Chevalier, M., Gallus, P., and Nagel, M. Contribution à l'étude du syndrome d'hypertension portale: étude clinique et portographique. (Contribution to the study of the syndrome of postal hypertension; clinical and portographic study.) *Acta gastro-enterol. belg.*, Dec., 1951, *14*, 795–804.

The authors divide the cases of portal hypertension into an intra- and extrahepatic group, according to the site of the obstruction. The extrahepatic group is subdivided into the portal (infrahepatic) and the suprahepatic group (Budd-Chiari syndrome). The different etiological elements responsible are enumerated in detail.

The points of differential diagnosis between portal obstruction due to thrombosis of the portal vein or the suprahepatic veins, on one side, and hepatic cirrhosis (intrahepatic obstruction), on the other side, are discussed. The rapid clinical evolution of thrombosis contrasts with the slow process of cirrhosis.

The differential diagnostic features between suprahepatic thrombosis and portal (infrahepatic) thrombosis are discussed and illustrated by 2 cases, one belonging to the former, the second to the latter group. A detailed clinical, laboratory and postmortem study of both cases was carried out. No roentgenographic examination was done in the first case. In the second case, an injection of contrast medium into the splenic vein postmortem revealed on the roentgenograms a thrombosis of the left branch of the portal vein. At autopsy, liver cirrhosis complicated by an old organized thrombus with almost complete obstruction of the left main branch of the portal vein was found.

Roentgenograms obtained after postmortem injection of contrast medium into the splenic vein in a case of atrophic liver cirrhosis without signs of portal hypertension and another similar case, but with portal hypertension, are also presented. Two more portal venograms, obtained in living subjects by transparietal injection of diodrast into the spleen, follow.

In 1 case, the venograms showed narrowing of the intrahepatic branches of the portal vein due to atrophic liver cirrhosis; in the other, a compression of the splenic vein, due probably to metastatic lymph nodes from a prepyloric carcinoma diagnosed previously, was present.

This is very interesting clinical and roentgenological study which complements the authors' article published in the same journal a month previously (see above abstract).—*Karol E. Matzinger, M.D.*

Gadermann, E., and Schrader, E. A. Zur Technik und Indikation der lumbalen Aortographie. (Technique and indications of lumbar aortography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, 670–678.

A technique of lumbar aortography is described. General anesthesia is never used because it is believed that the cooperation of the patient is of aid in getting good roentgenograms. Fifty cubic centimeters of contrast material (umbradil 70 per cent) is injected within a period of two to four seconds. The first roentgenogram is taken after 10 cc. of contrast material has been injected, the length of the exposure being about two seconds. Thus, the aorta and its branches can be visualized. This film is then inspected to determine if the filling is satisfactory, the cannula being washed out with saline in the interim, in case a second filling is necessary. The entire examination is done with the patient ambulatory.

Several types of complications may be observed. In one case, there was extensive para-aortic extravasation along the vertebral column. The patient had pain in the upper abdomen and a feeling of pressure in the thorax, the symptoms disappearing completely after one hour. Also, there may occur an infiltration of the aortic wall with the contrast material, a complication which should be of serious consideration. To avoid such complications, 4 to 5 cc. of the contrast material is injected slowly and the reaction of the patient awaited. Another complication is when a vessel other than the aorta is entered. The authors have injected the superior mesenteric artery, and the only symptom observed was a feeling of warmth in the abdomen.

Patients with coronary disease and with degenerative myocardial changes tolerate the examination without difficulty. Even calcification of the abdominal aorta presents no obstacle. A contraindication to aortography is inflammatory involvement of the kidneys, particularly when insufficiency exists. This is also true when the liver is affected similarly.

There is no doubt that aortography enriches our knowledge in the field of the study of blood vessels. Highly situated arterial vascular changes may thus be diagnosed and treated appropriately. The dis-

covery of obliteration of renal blood vessels in cases of unexplained arterial hypertension, the diagnosis of tumor of the kidneys and suprarenal glands, aneurysms, and anomalies of the blood vessels are some of the possibilities to be found with aortography. Occasionally, retrograde pyelography is combined with aortography to clarify certain pathological changes in the kidneys.—*Samuel Richman, M.D.*

GUILHEM, P., BAUX, R., VOISIN, R., and PAILLÉ, J. La phlébographie pelvienne par voie utérine. (Pelvic phlebography by the uterine route.) *Bull. féd. Soc. de gyn. et obst.*, 1951, *3*, 709–713.

This is a preliminary report on attempts at opacification of the uterine and ovarian veins following the injection of a 50 per cent solution of diodone into the uterine wall.

Ten patients were submitted to this study, and the roentgenograms obtained in 4 of them are shown, all of them post abortum. Some variations in the course of the uterine veins are described.—*Albert Oppenheimer, M.D.*

DUCUING, J., GUILHEM, P., ENJALBERT, A., BAUX, R., and PAILLÉ, J. Les différentes voies d'exploration pelvienne par la phlébographie. (Different routes of pelvic exploration by means of phlebography.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1951, *32*, 713–719.

The authors give a brief historical review of the methods of pelvic phlebography, as developed by de La Pêna and Amselem, de Sousa Pereira and by themselves. They state that, by using various routes for the injection of the opaque material, they have gained considerable experience and wish, therefore, to analyze in the present article the relative value of the various methods available.

The principal routes of injection for study of the pelvic veins are: (1) The arterial route—angiography or arteriovenography, of which the low aortography is the one most commonly employed, but its venous phase is unsatisfactory for the exploration of the pelvic veins. (2) The venous route, which includes the femoral vein, one of the hemorrhoidal veins, the spermatic vein and the deep vein of the penis or clitoris, with these last two giving the best results. (3) The spongy route, either through the corpus cavernosum of the male or female, the opacification in the latter being excellent, or through the spongy bone, the various transosseous approaches including the (a) pubic bone, (b) ischium, (c) trochanter, (d) iliac crest and (e) sacrum, with excellent opacification in all.

The indications for study of the pelvis by phlebography are divided into: (1) essential—for the demonstration (a) of the point of origin of a progressive phlebitis and of the "petits signes de Ducuing" proving that postoperative phlebitis usually starts within the pelvis, and (b) of the sequelae of phlebitis; in particular, the site of obstruction responsible for edema; (2) accessory—for the visualization of thrombosis in phlebitis and its sequelae and also for the visualization of the venous images in neoplasms, especially in cancer; and (3) experimental—for the investigation of certain anatomic details and of the venous physiology of the pelvis.

The choice of the preferred route of injection depends on several factors. (1) In the first place, one must be familiar with the pattern of venous circulation within the pelvis. The authors distinguish getween a parietal and a visceral circulation. The former includes an anterior or obturator current, an external or ischiogluteal current and a posterior or sacral current, whereas the latter comprises an anterior or vesical current, a median or genital current and a posterior or rectal current. (2) Then it must be admitted that despite all efforts no satisfactory visualization of the visceral circulation can be accomplished as yet, so that the sphere of injection must for the present remain limited to the parietal circulation. (3) It must also be admitted that all the routes of injection tried until now (including the deep dorsal vein of the penis and clitoris) have led to the opacification of the same vessels, although (4) certain local advantages may result from performing the injection through the most suitable avenue of approach. In this respect, additional experience is necessary until the final indications are definitely established. However, it already can be said that injection via the deep dorsal vein of the penis or clitoris and the corpora cavernosa is of great value when opacification of the pelvic veins on both sides is desired.

Transosseous phlebography has the following advantages: (1) it is easy to carry out and when performed bilaterally it gives good visualization of the entire pelvic circulation; (2) it permits the injection of large quantities of the opaque medium in a concentration, producing good impregnation of the pelvic veins; (3) it also renders visible the hypogastric and external iliac venous systems, thereby making possible a more accurate evaluation of the relationship of a thrombus to the common iliac vein than is possible by injection via the venous routes; (4) finally, it allows a more individualized selection of the site of injection for a particular study as, for example, in the pubic bone or ischium for opacification of the obturator venous system and its connection with the hypogastric system, in the trochanter for visualization of the upper portion of the femoral and external iliac veins, in the iliac crest for demonstration of the gluteal veins and their entry into the external iliac vein, and in the sacrum for outlining of the presacral plexus and its ramifications.

In concluding, the authors state that the correct interpretation of a pelvic phlebogram constitutes one of the most difficult problems and that a revision of the present approach may be expected.

The article is illustrated with diagrams and beautiful roentgenographic reproductions portraying typical phlebographic patterns.—*T. Leucutia, M.D.*

Reese, A. J. M., and Levy, E. Familial incidence of non-lipoid reticulo-endotheliosis (Letterer-Siwe disease). *Arch. Dis. Childhood*, Dec., 1951, *26*, 578–581.

Nonlipoid reticulo-endotheliosis had been reported many times since Letterer described the first case in 1924. The most recent reviews of the literature have shown no cases with familial instances.

The authors of this article report the cases of two sisters who both died of the disease in early infancy. Both patients had fever, hepatosplenomegaly and anemia. Both came to autopsy and the diagnoses seemed well substantiated. The conclusion drawn is that the disease may have inherited rather than environmental cause.—*R. E. Kinzer, M. D.*

Mazar, Steven A., and Straus, Bernard. Marital Hodgkin's disease; a review of the familial incidence and of etiological factors. *Arch. Int. Med.*, Dec., 1951, *88*, 819–830.

This article reviews the various theories as to the cause of Hodgkin's disease. The authors cite the reported familial cases of Hodgkin's disease. To this list they added the case record of a husband and wife who died of this disease. The husband died in 1945 and the wife in 1949. Autopsies were not obtained in either cases. As this is only the second instance of the disease reported in husband and wife, one must conclude that it was an incidental occurrence.—*J. H. Harris, M.D.*

General

Lipman, Bernard L., Rosenthal, Ira M., and Lowenburg, Harry, Jr. Arteriosclerosis in infancy. *Am. J. Dis. Child.*, Nov., 1951, *82*, 561–566.

The case reported in this paper presents the clinical and pathological findings of generalized arteriosclerosis occurring in a five month old infant, a white boy. The baby died of myocardial infarction which resulted from multiple coronary occlusions. A roentgenogram of the chest showed cardiac dilatation. At autopsy pericardial effusion was also found.

The etiology of the condition is unknown. There has been no demonstrable infective agent. Attempts to explain it by reference to a disturbance in calcium metabolism have been fruitless. While there is no other evidence of hypophyseal dysfunction, it remains possible that it may be related to progeria.

The disease should be differentiated from anomalous origin of the left coronary artery, transposition of the great vessels, idiopathic myocardial degeneration and fibrosis, and glycogen-storage disease of the heart.—*R. S. Bromer, M.D.*

Jackson, W. P. U. The clinical features, diagnosis, and osseous lesions of gargoylism exemplified in three siblings. *Arch. Dis. Childhood*, Dec., 1951, *26*, 549–557.

Three siblings suffering from gargoylism are described. Two of these are females and one is a male. Case reports and voluminous roentgen studies are given to illustrate the fundamental changes seen in this disease.

The symptom complex consists for the most part of two basic components. The first is a defect in cartilage development and accounts for dwarfing changes in the joints and spine and changes in the flat bones of the skull. The second is the storage of an abnormal substance in the reticulo-endothelial cells, as well as connective tissue all over the body. This storage substance accounts for the large liver and spleen and is responsible for heart failure, mental deficiency and other symptoms exhibited by these patients.

The author makes a careful attempt to differentiate gargoylism from Morquio's disease. He believes these diseases can be differentiated on roentgen appearance of the bones and joints.—*R. E. Kinzer, M.D.*

Hartweg, H. Über die Todesursachen bei Morbus Boeck. (The causes of death in Boeck's sarcoid.) *Med. Welt*, Dec. 22, 1951, *20*, 1604–1606.

The author states that Boeck's sarcoid is commonly underestimated as a disease with a possible fatal outcome. Of 400 cases, 70 have died either from the disease or from its sequelae. The author reports his own material of 80 cases with 3 fatalities.

The causes of death in Boeck's sarcoid fall into two groups: one comprising cases with involvement of one of the main organs of the body; the other, cases with secondary infection. In the first group, the organs most commonly involved are the lungs, heart or brain. Electrocardiographic changes are reported as well as formation of granulomas within the heart and brain. A number of patients died of involvement of the heart. The most common cause of death is extensive pulmonary involvement with chronic hypoxemia and terminal right ventricular failure.

In the second group, the cause of death is secondary infection due to markedly diminished resistance. —*E. G. Wissing, M.D.*

RADIATION THERAPY

Bergman, Martin, and Graham, Evarts A. Pneumonectomy for severe irradiation damage of the lung. *J. Thoracic Surg.*, Dec., 1951, *22*, 549–567.

The structural alterations resulting from relatively large quantities of radiation to the lung cause symptoms of cough, dyspnea, chest pain and hemoptysis. Pulmonary function is often severely impaired by

the process. The patient may be completely incapacitated and in extreme physical distress. In a unilateral case pneumonectomy is an effective therapeutic measure. Two patients with this disease who were operated on with palliation of symptoms are reported.

The authors believe that pneumonectomy should be employed in the treatment of unilateral radiation damage in those cases where the severity of symptoms warrants such a procedure. Whether the original tumor for which the irradiation was undertaken, is completely or only temporarily arrested is of secondary consideration, provided that the clinical history and examination make it appear that the patient will probably survive for a reasonable length of time. No hard and fast rules can or should be laid down in this respect.

Undoubtedly many patients who received radiation therapy to the chest sustain milder degrees of pulmonary damage. The authors point out that when such a condition goes unrecognized an erroneous diagnosis of pulmonary metastatic carcinoma may lead to further irradiation. Thus, a relatively innocuous and largely transient reaction may be converted into an incapacitating and frequently fatal disease. Because of this hazard they stress more general awareness of the pulmonary radiation symdrome and greater caution in applying irradiation to the thorax.—*T. C. Stansbury, Jr., M.D.*

Drescher, Heinz. Zur Behandlung des Röntgenkaters. (The treatment of radiation sickness.) *Med. Welt*, Dec. 1, 1951, *20*, 1523–1524.

The author reports on the use of thomapyrin, a combination of 0.2 gm. phenacetin, 0.25 gm. acetylsalicylic acid and 0.05 gm. caffein, to combat radiation sickness.

In observations made for one year, 19 out of 229 patients treated for cancer suffered from constitutional reactions of varying severity. All showed improvement with the use of one or two tablets of thomapyrin per day.

The author believes that the good effect of thomapyrin is due to the particularly favorable proportion of its components.—*Solomon Silvera, M.D.*

Pfahler, George E. Die Behandlung von Muttermalen mit besonderer Berücksichtigung des kavernösen Hämangioms. (The treatment of birthmarks with particular consideration of the cavernous hemangiomas.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, Supp., 141–160.

Pfahler believes that the proper selection of the method of treatment combined with experience is the essential factor for successful therapy of hemangiomas.

It should be known that the so-called port wine stains do not respond to any treatment, particularly not to radiation therapy.

Irradiation is considered the method of choice for the treatment of cavernous hemangiomas. Scars form only rarely if proper spacing between treatments is maintained. The site of the location of a former cavernous hemangioma often cannot be recognized later on except in those cases in which an ulceration was present before the treatment was started.

One must distinguish between two forms of cavernous hemangioma: (1) the strawberry type which is superficially located and is not thicker than 1 or 2 mm., and (2) the large, cavernous, tumor-like type which is usually thicker and often multiple. These lesions can involve the face or other parts of the body quite extensively.

A small strawberry hemangioma can be easily destroyed by freezing, with the electric needle or by electrocoagulation. When irradiation is employed one should use doses which are slightly below an erythema dose and should repeat this treatment in approximately six weeks to two months. The use of radium with plaques of 5 to 10 mg. strength is also recommended. Radium has the advantage that its range is self limited and superficial. The distance of the radium from the surface should correspond approximately to the depth or thickness of the lesion. Radium in any form should be properly filtered and only gamma rays should be employed because they give the best cosmetic effect in the author's experience.

The use of radium is contraindicated in lesions which overlie the scrotum or the ovaries. Neither should radium be used in the hairy portion of the skull because of the danger of later alopecia, although this is only rarely noted. The application of radium above epiphysis of fingers and toes may influence the growth of the bone later on. A treatment with radium usually necessitates several applications and consultations and may last for a year or longer in order to bring about satisfactory results. It is therefore simpler in certain instances and less time consuming to use electrosurgery and subsequent skin transplantations.

A treatment with fulguration is indicated only when the lesion is small and superficial and lies in a location where a small scar would not be cosmetically noticeable.

The treatment of the large tumor-like cavernous hemangiomas varies according to size, form, number and thickness of the lesion. The use of roentgen therapy is preferable to the use of radium. Hemangiomas of the vertebral bodies, of the joints and even of the larynx have favorably responded to irradiation in the author's experience.—*H. P. Mueller, M.D.*

Alonso, Francisco Arce. Le traitement radiothérapique des bursites et péri-arthrites scapulo-humérales. (Radiotherapy of humero-scapular bursitis and periarthritis.) *J. belge de radiol.*, Dec., 1951, *34*, 389–400.

The author believes that periarthritis, bursitis and tendinitis are different localizations of the same basic disease. In his experience, roentgen therapy yields better results than other modes of treatment, including surgical operation, short-wave diathermy, iontophoresis, galvanization, infrared and ultraviolet treatment and ultrasonic therapy.

The clinical and roentgenologic features of the disease are described.

Roentgen therapy, as used by the author, consists of a total of about 1,000 r through a single field 10 by 15 cm., with 200 kv., 1 mm. Cu plus 2 mm. Al filter. The first treatment is given with 100 r; then 150 r is administered three times weekly.

Over a period of nine years, this course of treatment was given to 58 patients with acute bursitis, resulting in 52 cures, 6 improvements, and no failure. In 18 patients with subacute bursitis, there were 10 cures, 2 improvements and 6 failures. Of 22 patients with chronic bursitis, 12 were cured, 3 improved, and 7 were considered unimproved.

The article contains 6 roentgenograms showing various forms of calcification about the shoulder joint, including chondromatosis.—*Albert Oppenheimer, M.D.*

De Maestri, Alfredo. Le traitement roentgenthérapeutique dans la maladie de Still. (Roentgen treatment of Still's disease.) *J. belge de radiol.*, Dec., 1951, *34*, 406–415.

The author reports the result of roentgen therapy in 2 cases of Still's disease. The girls, aged six and eight years, had typical clinical manifestations: periarticular swelling, lymph node enlargement, muscle atrophy and disability, not responding to the usual types of medical treatment, including antibiotics. Both patients began to improve rapidly as soon as roentgen therapy to the affected joints was instituted, the most striking amelioration being the ability of these children to walk and even run again, although the articular deformities persisted.

The author administered 100 r per field, each field being treated with the same dose again after twenty days. The factors were 180 kv., with a filtration of 0.4 mm. Cu plus 3 mm. Al. It is believed that the results were due to both the analgesic and the cytolytic effect of the roentgen therapy. The article contains reproductions of 6 roentgenograms showing the characteristic articular lesions.—*Albert Oppenheimer, M.D.*

Huard, P., Olivier, A., and Tran-Anh. Traitement radiothérapique des hémato-lympho-chyluries filariennes. (Radiation therapy of hemo-lympho-chyluria due to filariasis.) *J. belge de radiol.*, Dec., 1951, *34*, 498–518.

This report comes from French Indochina, where much attention has been paid to the urinary complications of filariasis since 1936. Roentgen therapy has been used for tropical diseases since the beginning of the century, particularly by American workers, whose technique is quoted.

The authors are administering roentgen therapy in filariasis with the following factors: 180–200 kv.; 1 or 2 mm. Cu plus 2 mm. Al; an anode-skin distance of 40 or 50 cm.; two dorsolumbar fields of 8 by 10, 10 by 10 or 10 by 15 cm. depending on the size of the patient, with an additional epigastric field; each field receiving 150 r per day (skin dose) for a total of 1,000–1,500 r per field. The first treatment is occasionally followed by elevation of temperature, headache, tachycardia and backache, which usually subside within two to three days. No other side-effects are noted. In favorable instances, the urine becomes clear soon after beginning of the treatment, then the microfilariae disappear, followed by disappearance of the fat globules. Finally, retrograde pyelography reveals that there is no longer any lymphorenal communication.

In all, 29 patients were submitted to this type of treatment since 1943 and 30 per cent were cured by roentgen therapy alone. Of 15 patients treated during the last year, 8 were cured, 2 definitely improved, and 5 showed no response.

The mechanism of action of the roentgen rays is discussed. Eight roentgenograms are reproduced in the article, showing pyelolymphatic communications and their disappearance after treatment. The results of roentgen therapy in the 29 patients are tabulated.—*Albert Oppenheimer, M.D.*

Zondek, Herman, and Ticho, Albert. Myasthenia gravis and malignant exophthalmos; report of a case. *Lancet*, Dec. 1, 1951, *2*, 1018–1020.

The authors report the very interesting combination of myasthenia gravis and malignant exophthalmos in a sixty year old farmer. Symptoms of muscular weakness began in 1946. Myasthenia gravis was diagnosed and prostigmin was given by mouth and parentally. The condition did not improve although repeated roentgen irradiation of the thymus produced some temporary relief. In 1948, after eight courses of roentgen therapy, the patient began to lose weight and complained of palpations and nervous excitability. The basal metabolic rate was +28 per cent. Treatment with propylthiouracil had no effect on either the symptoms or the basal metabolic rate. In 1950, the eyes began to protrude and there was progressive lacrimation and conjunctival inflammation. Sugar was found in the urine and insulin was given. Subsequently, the sugar disappeared despite the withdrawal of insulin. Late in 1950, there

was marked loss of muscular tone, extreme exophthalmos, glaucoma, severe precordial pain and edema of the extremities. The blood sugar level was normal in the fasting state with a latent diabetic curve on a glucose tolerance test. Volhard's test of renal function showed retention of water. The Robinson-Power-Kepler test index was 13.2.

There was no improvement on diiodotyrosine. After a total dose of 640 mg. of ACTH (adrenocorticotropic hormone) both the protrusion and the inflammation of the eyes were aggravated. There was increased ocular tension. ACTH was discontinued, and pain and intraocular tension were relieved with mercurial diuretics.

In January, 1951, roentgen therapy was given to the pituitary gland and continued until February 9 (total dose 3,000 r). About a month later, the patient's general condition was definitely better; this improvement has steadily continued. After five months there is steady improvement, the patient resuming his farm work and reducing his daily dose of prostigmin to one injection and seven tablets. The exophthalmos has reduced and there is no glaucoma. The Robinson-Power-Kepler index is 30; the other chemistry is normal. The basal metabolic rate is +6 per cent. Spontaneous regression was thought improbable. The evidence would indicate that the pituitary-diencephalic region is the seat of such a disturbance.—*T. J. Wachowski, M.D.*

Friedman, Milton, and Davis, Lawrence A. "Single portal-massive-dose" x-ray therapy technic for certain upper respiratory tract, parotid gland, and recurrent breast cancers. *Radiology*, Dec., 1951, *57*, 797–819.

Earlier investigations of skin reactions indicated that the skin and mucosa of one-fourth of all adult patients were relatively radio-immune and could tolerate large doses of roentgen radiation. Over a period of about ten years the authors gradually increased the total dose delivered to one skin portal on the head and neck from 4,000 to 6,000 r and finally to 8,000 r. As a result of these studies, it was concluded that the skin can tolerate a dose of 8,000 r delivered over a period of five weeks or longer to a field measuring approximately 8 by 10 cm. Radiation qualities ranged from 1.0 to 2.0 mm. Cu half-value layer, except for four patients who were treated with radiation of 10 mm. Cu h.-v.l. (1,000 kv.). Daily skin dose ranged from 300 to 400 r. Recommended "over-all time" for the duration of treatment was twenty-nine to thirty-five days.

The distribution of cases in this series receiving varying total skin doses was as follows:

Range in r	*Number of cases*
4,001–5,000	6
5,001–6,000	21
6,001–7,000	19
7,001–8,000	21
8,001–8,450	7

The single portal technique is advised for lesions whose deepest extension is not more than 4 cm. from the skin. Lesions of the tonsils, pharynx, tongue, larynx, floor of the mouth, metastatic carcinoma in cervical lymph nodes and parotid carcinoma are all considered suitable for this form of treatment. With an 8 by 10 cm. field and a total skin dose of 8,000 r, the tumor dose at 4 cm. depth is 5,360 r.

Skin and mucosal reactions were studied and are recorded in a series of graphs. With total skin doses of 7,000 r in thirty-five days the epidermitis healed within seventy-seven days in all cases but moderate late fibrosis and atrophy occurred. Patients who received skin doses ranging from 7,000 to 8,000 r in twenty-eight to thirty-five days showed occasional severe reaction. Late skin changes ranged from mild atrophy with telangiectasis to necrosis.

It is concluded that single portal, massive dose technique increases the potentiality for radiocurability of certain squamous cell carcinomas and their metastatic nodes.—*A. W. Sommer, M.D.*

Krebs, Carl. A critical evaluation of the present classification of cancer of the breast based on the frequency of metastases. *Forstchr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, 93–97.

The author is of the opinion that Steinthal's classification of cancer of the breast is of no value because at operation all or nearly all patients have metastasis. Steinthal's classification comprises three stages, which are as follows: Stage I, tumor confined to breast; Stage II, tumor of breast with axillary metastasis; Stage III, tumor of breast with axillary and supraclavicular and possibly distant metastases.

In a study of several series of cases, the error in classification varied from 28 to 67 per cent in Stage I cases and from 12 to 32 per cent in Stage II cases. In a previous paper the author showed that a tumor which had been irradiated and implanted into a mouse may remain symptomless for almost twelve months. On the basis of this work and the impossibility of accurate classification, the author believes that the results of radiation therapy should be revised.

There are four principal forms of roentgen and radium treatment: (1) Postoperative roentgen therapy with about 300 r given four times at intervals of ten days. The author believes this produces a stimulation of the organism which will then kill remaining tumor cells liberated during the operation. (2) and (3) Preoperative and postoperative therapy in doses of from 1,200 to 2,400 r. According to the author's theory this dosage may attenuate the tumor cells and stimulate the organism to combat them. (4) Large roentgen doses of from 4,000 to 8,000 r. These doses may kill the tumor cells but may also impair the power of the organism to combat the malignant cells. The local application of radium as it is used in Norway with good results belongs to this fourth method.—*Joseph N. Ané, M.D.*

Schmitz, Herbert E., and Majewski, Joseph T. End-results in the treatment of ovarian carcinoma with surgery and deep x-ray irradiation. *Radiology*, Dec., 1951, *57*, 820–825.

This analysis is based on a study of 143 cases of malignant ovarian neoplasms.

Management of the patients in this series included both irradiation and surgery. All but 2 received roentgen therapy. Five year survival rate is 20.3 per cent. Eliminating those cases in which only supportive therapy was undertaken gives a corrected survival rate of 27.5 per cent. When complete surgical removal of the gross disease was possible, the survival rate was about 50 per cent. Papillary cystadenocarcinoma, pseudomucinous adenocarcinoma and adenocarcinoma constitute about 83 per cent of the five year survivals.

Abdominal swelling or the presence of a mass was the observation that brought 65 per cent of the patients to consult a physician. This study failed to reveal a characteristic symptom which would indicate to the patient or to her physician the possible presence of such a lesion in its incipiency. Routine pelvic examination at frequent intervals seems to offer the only solution to the problem of early diagnosis.

Surgical removal of the entire uterus, both tubes and ovaries, plus the omentum, followed by intense irradiation of the entire pelvis was the treatment employed. The plan of irradiation consisted in delivering a total tumor dose of 4,500 to 5,000 r.—*A. W. Sommer, M.D.*

Boden, Geoffrey, and Gibb, Robert. Radiotherapy and testicular neoplasms. *Lancet*, Dec. 29, 1951, *2*, 1195–1197.

Testicular neoplasms include very rapidly growing, widely metastasizing tumors which are amenable to surgical cure only when the growth is confined to the primary site. The general clinical picture is a primary tumor which may be removed surgically although it may be associated with metastases which may not be detected until they are far advanced.

In reporting survival rates of cases with testicular neoplasms, the authors believe that differentiation must be made between the results for seminoma and those for teratoma. Thus, in this series, tumors reported as seminoma, carcinoma of the seminal epithelium, or embryonal carcinoma have been classified as seminoma. Those histologically reported as malignant teratoma, adenocarcinoma or chorion carcinoma have been classified as teratoma. Others were unclassified either because the pathological findings were unknown or a more precise definition was impossible. Of 128 consecutive neoplasms, 96 were seminoma, 17 were teratoma and 15 were unclassified.

In 52 per cent of the patients metastases were already present and their incidence was approximately equal in the seminoma and teratoma groups. Because of the importance of metastases in prognosis, the main groups were subdivided into those having no demonstrable metastases (group A), those with intra-abdominal metastases (group B), and those with extra-abdominal metastases (group C).

In seminoma, of 50 patients of group A 80 per cent survived five years; of 29 patients of group B 41 per cent; and of 17 patients of group C 12 per cent.

In teratoma the corresponding figures were: group A, 50 per cent of 10 patients; group B, 25 per cent of 4 patients; and group C, none of 3 patients.

In the unclassified tumors both patients of group A, 1 of 6 patients of group B and none of 7 patients of group C survived a five year period.

Patients classed as five year survivals had no evidence of neoplastic disease at the end of that period and where patients were untraced or dead from intercurrent disease they were considered to have died of neoplasm.

The authors emphasize the importance of a careful simple orchidectomy as the primary treatment which also aids in planning radiation therapy and in prognosis.

Comparing the gross five year survival rate of 49 per cent in their series with other results cited in the literature the authors strongly recommend that every case of testicular neoplasm which has been treated by orchidectomy be subjected to roentgen therapy despite the nature of the tumor or the presence of metastases.—*Robert W. Emerick, M.D.*

RADIOISOTOPES

Sorrentino, Joseph, Roswit, Bernard, and Yalow, Rosalyn. Thyroid carcinoma with multiple metastases and pathological fracture, successfully treated with radioiodine; report of a case. *Radiology*, Nov., 1951, *57*, 729–737.

Thyroid carcinoma is relatively rare, contributing only about 0.4 per cent to the total recorded cancer deaths. Prior to the introduction of radioiodine, patients with distant metastases were regarded as completely hopeless. Now such patients who demonstrate a significant uptake of I^{131} by the metastatic foci are treated with that agent.

Unfortunately, not more than 15 per cent of metastatic thyroid carcinomas will pick up radioiodine in amounts that have therapeutic significance. Only a small proportion of thyroid cancers, particularly those of slow growth and adenocarcinomatous nature with good morphological differentiation, will approach the iodine-concentrating power of normal thyroid tissue. The radioiodine pick-up of the metastases of a thyroid carcinoma does not necessarily parallel the pick-up of the primary lesion.

A small group of patients with far advanced dis-

ease and generalized metastases, particularly to the skeleton, have responded favorably to radioiodine therapy. A few have been maintained in reasonably good health for variable periods up to and beyond the five year mark.

A case report is given of a patient with papillary follicular adenocarcinoma of the thyroid gland with multiple bony and soft tissue metastases. Healing of pathological fractures and marked general improvement occurred subsequent to treatment with I^{131}. He received a total of 1,246 millicuries of I^{131} over a period of two years. Improvement began two months after institution of radioiodine therapy. Pathologic fractures of the spine and the left scapula healed under radioiodine and have remained healed. He has been free from pain and clinically well over a period of more than two years, and gained weight and resumed his regular occupation.

Striking histopathologic changes due to irradiation were demonstrated in the metastatic foci. Cell death is manifested by lysis of the nucleus and cytoplasm, and to a lesser extent pyknosis and karyorrhexis of the nucleus. Radiosensitive cells undergo acute cell death, but those less radiosensitive show progressive enlargement. Vacuolation of the cytoplasm and the nucleus and abnormal nuclei are common. Ultimate stromal changes appear to be reactive phenomena secondary to the destruction of neoplastic cells.

Minimal changes were noted in the hemopoietic system and there was a mild degree of renal tubular damage attending the treatment as given.—*A. W. Sommer, M.D.*

Kent, Edward M., and Moses, Campbell. Radioactive isotopes in the palliative management of carcinomatosis of the pleura. *J. Thoracic Surg.*, Nov., 1951, *22*, 503–516.

This is a report of 19 patients with established carcinomatosis of the pleura and a rapidly forming, intractable pleural effusion who were treated by the local injection of radioactive isotopes into the pleural space.

In most of the cases I^{131} was used but Au^{198} and I^{131} tagged human albumin were also employed in a limited number of cases. A dose of 10 millicuries of I^{131} was given initially, but this was later raised to as much as 30 millicuries. Under local anesthesia the pleural effusion was aspirated as completely as possible. During the aspiration the I^{131} containing bottle was filled with pleural fluid. At the conclusion of the aspiration, the I^{131} containing pleural fluid was reinjected into the pleural cavity.

In 13 patients of this series with metastatic carcinoma the formation of pleural fluid was completely checked by the administration of radioactive iodine, iodine tagged albumin, or radioactive colloidal gold. Three of the patients died too soon after therapy to evaluate the results and in 3 patients the formation of pleural fluid was definitely retarded but not entirely checked. No toxic manifestations from the administration of the isotopes were noted in this series. —*T. C. Stansbury, Jr., M.D.*

James, Arthur G., Williams, Roger D., and Morton, Joseph L. The use of radioactive cobalt in nonresectable head and neck cancer. *Cancer*, Nov., 1951, *4*, 1333–1336.

Work at the Ohio State University Medical Center with Co^{60} has been in progress since 1948. The cobalt used in this work is in the form of cylinders measuring 0.508 mm. in diameter and 3.0 mm. in length with an initial gamma-ray intensity for each cylinder that is equivalent to that of one-third of a millicurie of radium. These cylinders are placed within flexible nylon tubing that completely filters the beta radiation and is readily sutured into irregular volumes of tissue or around or near major blood vessels. Other advantages of cobalt include its low cost and easy calibration. It can be easily handled since it is a magnetic metal, and it forms no gaseous radioactive product on decay as does radium, and therefore is safer to handle. It is not an element selectively absorbed by bone as is radium, so that dangers involved in breakage are eliminated.

The nylon applicators are sterilized by boiling. While warm, the ends of the applicators may be stretched thin so that they can be threaded through the eye of a needle. Guide needles, flat or curved, are implanted throughout the field to be treated at distances of 1 cm. apart. The needles are then threaded, and the Co^{60} applicators are pulled into proper position. By loading the applicators properly and spacing them 1 cm. apart, the various parts of the tumor will receive a total dose of 1,000 r per day. The Co^{60} is left in place for an average of seven to ten days and withdrawn without anesthesia. The nylon should be used within four weeks since the beta radiation absorbed makes it brittle after this time.

The clinical material discussed in the article is classified according to the various locations of the non-resectable head and neck cancers in which this method was used. All the cases had received previous treatment in the form of surgery or other types of radiation. The 3 specific cases described in this article showed excellent regression of the tumor following Co^{60} irradiation.

The conclusion is reached that it is possible to give more uniform irradiation throughout a volume of tissue with Co^{60} than with other forms of interstitial irradiation, with greater safety to bone and previously irradiated tissue.—*H. Griffith, M.D.*

Angrist, Alfred A., Schwarz, Alfred W., Brodie, S. Steven, and Shapiro, Alfred J. Study of early phases of calcification in bone with radioactive phosphorous. *Bull. Hosp. Joint Dis.*, Oct., 1951, *12*, 87–109.

The element phosphorus has a more active bio-

chemical role than calcium or the other mineral elements of the bone. Phosphorus seems to be replaced in thirty days in the rabbit while the bone salts as a whole have a turnover rate of 230 days. This fact indicated to the authors a significant role for phosphorus in bone metabolism and justified its detailed investigation in normal and pathological processes, especially since radioactive phosphorus is well suited for the study of the participation of this element in the earliest manifestations of bone metabolism.

The use of P^{32} is presented in a study of *early* calcification changes in normal bone and in some controlled states of pathological alteration. For the early active changes in calcification, the bones of young, rapidly growing rats were employed. Further control of early calcification, from the standpoint of known timing, was attempted by the induction of florid rickets in young rats and then the sudden correction of this defect by a large dose of viosterol.

The uptake studies with P^{32} were performed on (1) normal animals; (2) normal animals with fractures of the femur or of the tibia; (3) rachitic animals; (4) rachitic animals with fracture of the femur or tibia; and for the determination of the (5) effect of vitamin D in considerable dosage; (6) effect of ACTH; and (7) effect of ACTH and vitamin D combined on these separate groups of animals.

One hour after the administration of P^{32} most of the animals were sacrificed and the femur and tibia of the broken and the control limbs without fracture were removed, placed in Bloor's solution and stripped of all soft tissue. Measurements of radioactive uptake by Geiger-Müller tubes were done on the clean separate dry bones and by the ionization chamber on the wet ash. Some of the bones had separate histological studies, and radioautographs were made on the dried bones of all the animals, with corresponding roentgenograms of the bones. The collected data on each of the seven groups of animals is presented in chart form together with the details concerning each group. In addition, radioautographs and roentgenograms of individual representative bones are presented.

The authors conclude that P^{32} is deposited selectively at sites of active bone metabolism and bone calcification. This increased deposition of P^{32} in callus sites and epiphyses is demonstrated by actual measurement of radioactivity and by the radioautographs. Characteristic radioautographs, confirmed by actual count measurements of selective bone sites, are obtained within five minutes after intraperitoneal injection, and are apparently independent of the variation in the specific activity of the blood. This deposition indicates a physicochemical phenomenon of the nature of anionic exchange and adsorption, rather than an enzymatic, metabolic or growth differentiation process.

The specific activity of the callus site is of approximately the same magnitude as that of the epiphysis proper.

Callus sites in rachitic animals show decreased activity as compared to the normal callus.

Viosterol does not affect P^{32} uptake in nonrachitic bone. Viosterol does increase adsorption of P^{32} in the rachitic bone and this is evident before the silver line test for the demonstration of calcification becomes positive.

ACTH decreases the uptake of P^{32} in normal bone and in normal callus. This effect by ACTH is also noted in rachitic animals. Some exceptions are encountered which lack an adequate explanation.

No significant *general* effect on the skeleton throughout the body seems apparent by immediate uptake studies following a *local* bone fracture.—*R. B. Jeffrey, M.D.*

Tubiana, M., Benda, Ph., and Constans, J. Sodium radio-actif ^{24}Na et liquide céphalo-rachidien; applications au diagnostic des méningites tuberculeuses et des compressions médullaires. (Radioactive sodium, Na^{24}, and cerebrospinal fluid; application to the diagnosis of tuberculous meningitis and medullary compression.) *Rev. neurol.*, 1951, *85*, 17–35.

The authors studied the rapidity of appearance of radioactive sodium and its relative concentrations on both sides of the hemomeningeal barrier in 65 cases on their neurosurgical service. The radioactive sodium was supplied in the form of sodium chloride with a specific activity of 1–2 millicuries per gram. It has a half-life of 14.8 hours and it emits both beta particles and gamma rays. Injections of Na^{24} were given intravenously at the elbow, 4 to 5 cc. of a hypertonic solution, and were followed within one hour by 0.5 cc. samples of cerebrospinal fluid taken by lumbar, cisternal, and ventricular punctures. Studies were also made with intraventricular and lumbar injections of Na^{24} in dilute solution, administered slowly after the equivalent amount of cerebrospinal fluid was removed first to prevent pressure alterations, the patient sitting upright. Samples of blood and cerebrospinal fluid were then taken at regular intervals. The rate of diffusion of Na^{24} along the spinal canal was also studied by an external counting mechanism.

The results of intravenous injections showed that within one hour the concentration of Na^{24} in the cerebrospinal fluid was three to four times greater in the ventricles than in the lumbar region, the ventricular concentration measuring about 70 per cent of the blood concentration. In tuberculous meningitis, on the other hand, the findings were reversed; the lumbar concentration was several times greater than the ventricular concentration and rapidly approached the blood level. A tendency of the lumbar/ventricular ratio to revert to normal in tuberculous meningitis may be indicative of a remission.

Following the lumbar injection of Na^{24} into the spinal fluid, there is a slow upward diffusion towards the ventricles with equilibrium reached in about three hours. On the other hand, after intraventricular injection, there is a rapid descent to the lumbar area. In both instances, Na^{24} can be detected in the blood in weak concentration within fifteen minutes. The rate of diffusion of Na^{24} along the spinal canal can be studied by external counting methods, which may be useful in the diagnosis of medullary block.

The authors believe that, while the choroid plexuses play a major role in the ion exchange between blood and cerebrospinal fluid, it is necessary to take into account the permeability of the capillaries of the subarachnoid space which, in cases of medullary compression, permit a concentration of Na^{24} in the lumbar region of the spinal fluid after intravenous injection. The well known increased permeability of the meninges in tuberculous meningitis is confirmed by these studies with Na^{24} which can also be used both as a diagnostic test for this disease and as a measure of its progress.—*S. M. Silverstone, M.D.*

Fitzgerald, Patrick J., Eidinoff, M. L., Knoll, J. E., and Simmel, E. B. Tritium in radioautography. *Science*, Nov. 9, 1951, *114*, 494–498.

The authors state that a major aim of radioautography is to be able to localize the site of energy emission on an intracellular level. Such fine delineation is difficult to achieve due to the usual high energy of most beta particle emitters, which will give wide grain spacing in the emulsion at the beginning of the track. Other problems, such as emulsion thickness, are also considered.

Tritium, a radioactive isotope of hydrogen of twelve years half-life, has a weak beta particle and a range of less than 2 microns (90 per cent, 0.2 micron) in the average nuclear photographic emulsion. A graph of counting rate versus absorber thickness clearly demonstrates the short range.

Various nuclear track emulsions were exposed under controlled conditions to tritium standards and the region of proportionality of density to intensity is plotted.

Paramecia and also yeast were grown in tritium containing media. After appropriate steps of fixation, dehydration, etc., the specimens were placed on photographic emulsions. Non-radioactive paramecia and yeast after identical treatment were similarly exposed on emulsions to rule out a chemophotographic effect.

Resolution of less than 1 micron was obtained with yeast. Photomicrographs of radioautographic specimens of yeast and paramecia are shown.

Various mechanisms for incorporating tritium as a label in organic compounds are discussed.—*Z. S. Gierlach, M.D.*

Brucer, Marshall. Radioisotope hazards and protection in a hospital. *J.A.M.A.*, Dec. 29, 1951, *147*, 1745–1751.

As the use of radioisotopes grows, safety measures become increasingly important. Ideas on how to handle radioisotopes are still in a state of flux, even on so rudimentary a question as which is the best material to be used for easily contaminated laboratory table tops. During 1950, stainless steel with a high polish was the accepted material. Such old-fashioned material as alberene soapstone was "out of the question." Now tests seem to indicate that stainless steel is one of the most difficult of all materials to decontaminate while soapstone can be cleaned readily with a piece of emery paper.

Experience at Oak Ridge Institute provides a basis for discussion of contamination and protection problems in hospitals where radioisotopes are in use on a smaller scale. Assuming that laboratory procedures and design are acceptable, radioactivity constitutes a hazard only after the material is injected into a patient. A patient who has received a radioisotope may constitute a hazard to other patients in adjoining beds and even in adjoining rooms separated only by ordinary plaster walls. The distance at which the patient is a hazard depends upon the quality of radiation emitted by the radioisotope selected. The duration of the hazard depends upon the half-life of the isotope. A portable Geiger-Müller type monitor can be used by nurses to outline the danger zone.

Shielding can be accomplished most simply by building the walls of certain rooms of dense concrete. Marble slabs can be added to existing walls. Metal screens mounted on casters can be rolled into place around a bed.

Assuming that personnel would spend the rest of their lives with some exposure to radioactivity, 300 milliroentgens total body exposure per week or 6.25 milliroentgens per hour is generally accepted, at the moment, as the maximum permissible dose level of exposure.

Personnel attending the patient and those handling urine, feces, blood, and tissue samples from the patient should wear pocket dosimeters for frequent checking by a health physicist. With care, the exposure can be kept below that received by personnel in the roentgen department. Commercially available handling equipment now includes lead-shielded syringes with a special locking device to prevent accidental discharge of syringe content, special intravenous infusion apparatus, remote handling bottle tongs, and shielding bricks. Soapstone bricks can be bought for as little as $1.35 each. With trained personnel using common sense and suitable equipment, the use of radioisotopes in hospitals should not involve significant hazard.—*George Cooper, Jr., M.D.*

Coliez, Robert, Tubiana, Maurice, Dutreix, J., and Guelfi, J. Résultats de l'exploration de 85 cas de cancers de la thyroïde par l'iode radioactif. (Results of exploration of 85 cases of cancer of the thyroid by means of radioactive iodine.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1951, *32*, 881–895.

The authors used radioactive iodine (I^{131}) for the study of 85 cases of proved cancer of the thyroid by paying attention to the following points; (1) diagnosis of cancer of the thyroid; (2) detection of metastases; (3) therapeutic indications; and (4) control of the progress of the disease.

The technique consisted of the oral administration of 200 microcuries to 1 millicurie of I^{131} in the morning on an empty stomach. The first examination was made twenty-four hours later, followed by a second examination within two to three days after the radioactivity of the blood had decreased. On each occasion two sets of measurements were made, one at 45 cm. fixed and always identical distance from the neck for the survey of the total radioactivity of the thyroid gland, and the other in contact with the neck for analysis of particular points or very limited areas. This latter usually required numerous counts. Topographic isoactivity charts were prepared by using various types of collimators adapted for the problems under study.

The following conclusions were reached:

(1) In view of the fact that cancer tissue always takes up less I^{131} than the normal thyroid tissue, topographic isoactivity charts furnish interesting data which, after comparison with the contour of the tumor, might be used for the diagnosis of a malignant tumor.

(2) Metastases have been present in 22 patients. In 10 of these the metastatic foci showed an I^{131} uptake which was easily demonstrable by external counting; in 7 cases one or several metastases which went unrecognized by clinical and roentgenographic study were discovered with the aid of I^{131}.

(3) The determination of the avidity of the cancerous tissue for I^{131} permits a proper selection of those patients with carcinoma of the thyroid who would respond favorably to radioactive iodine therapy. In the authors' series, 25 of 85 cases received such therapy.

(4) Repetition of the I^{131} tracer study at fixed intervals gives interesting information as to the progress of the disease.—*T. Leucutia, M.D.*

Harsha, William N. Evaluation of the conversion of radioactive inorganic iodine to protein-bound iodine as a diagnostic aid in thyroid dysfunction. *J. Clin. Endocrinol.*, Dec., 1951, *11*, 1524–1534.

The purpose of this study was to evaluate the conversion ratio of inorganic radioactive iodine into protein-bound radioiodine. Early workers in the field have shown that serum protein-bound iodine probably represents circulating thyroid hormone. Thus measurement of the rate of conversion of inorganic radioiodine to protein-bound iodine in the serum is suggested as a method of determining thyroid hormonal function.

Eighty patients were studied; these were about equally distributed among hypothyroids, euthyroids and hyperthyroids. Each patient was given a tracer dose of 100 microcuries of radioiodine (I^{131}). Blood samples were taken at hourly intervals for thirty-six hours, and then at twenty-four hour intervals for six days. Urine samples were collected at 8, 16, 24 and 30 hours, and then at twenty-four hour intervals for six days. Total plasma radioiodine activity in each sample was separated into protein-bound thyroxine, diiodotyrosine and inorganic radioiodine. Total urine radioiodine activity was measured and calculated in terms of the percentage of the ingested dose. Results showed that the serum protein-bound iodine, whether determined chemically or assayed as conversion of inorganic radioiodine into protein-bound radioiodine, regularly parallels the diagnosis and clinical course of thyroid dysfunction. The thyroxine and protein-bound iodine values were nearly identical, justifying the impression that protien-bound iodine measures thyroxine iodine. (This is an important consideration, because of the ease of assaying protein-bound radioiodine and the relative technical difficulty of assaying thyroxine radioiodine.) No correlation between protein-bound radioiodine levels and total protein values were found in this study.

Again the authors noted that the basal metabolic rates and the values for serum or plasma cholesterol did not reliably predict the clinical diagnosis.—*John P. Storaasli, M.D.*

Smith, Curtis A., Oberhelman, Harry A., Jr., Storer, Edward H., Woodward, Edward R., and Dragstedt, Lester R. Production of experimental cretinism in dogs by the administration of radioactive iodine. *Arch. Surg.*, Dec. 1951, *63*, 807–820.

Radioactive iodine (I^{131}) was given to pregnant bitches near term or to pups at varying intervals after delivery. The mother was permitted to nurse her young and an attempt was made to preserve 50 per cent of the litter as a control. There were, however, no controls for the pups that received I^{131} in utero as a result of injection of the mother. Thyroid function was estimated by determination of the conversion ratio of free to protein-bound iodine after the method of Clark.

The treated animals immediately grew at a slower

rate with short extremities and body. However, they were heavier in body fat.

The dog has the same bone changes in cretinism as has been reported in other animals. The defect in development is one of endochondral ossification. The width of the shaft of long bones is normal but the length is decreased because of delayed appearance and poor development of the secondary centers of ossification, as well as disorderly and impaired laying down of osteoid and bone at the epiphyseal lines. There was also a delay in closure of epiphyseal lines. Prognathia, similar to that seen in acromegaly, developed in 2 dogs.

In dogs who received I^{131} ten days to three weeks prior to death, some remnant of thyroid was found. No colloid was found. After five weeks either no remnant or a remnant consisting only of areolar tissue was found. The parathyroids appeared to be not at all damaged grossly and showed only an increase in fibrous tissue microscopically.

Cretinism in dogs is characterized by impairment of growth and skeletal development, obesity, lethargy, coarse, dry skin and hair, and, occasionally, protruding tongues.

Cretin dogs have hyperlipemia and hypercholesteremia, and conversion of free to protein-bound iodine is depressed.

Associated endocrine changes are the immaturity of the gonads and increase in the size of the pituitary.—*C. P. Truog, M.D.*

Blackburn, Charles M., Keating, F. Raymond, Jr., and Haines, Samuel F. Radioiodine tracer studies in thiocyanate myxedema. *J. Clin. Endocrinol.*, Dec., 1951, *11*, 1503–1511.

The authors report on 15 patients who developed myxedema as a result of the administration of potassium thiocyanate for hypertension. This study was done on 4 men and 11 women with ages ranging from forty-eight to sixty-four years. The results of this study indicate that in general when there is a prolonged high level of thiocyanate in the blood there is a diminished accumulation of radioiodine by the thyroid gland.

Observed evidence to support this conclusion was the fact that after the administration of potassium thiocyanate for an average of thirty-one months (six to sixty month range) there was: (1) a lowered extrarenal I^{131} disposal rate; (2) a lowered twenty-four hour in vivo I^{131} thyroid uptake count; and (3) an increased forty-eight hour urinary I^{131} excretion. It was also observed that the withdrawal of potassium thiocyanate usually resulted in prompt spontaneous disappearance of the myxedema and goiter (if present) and a marked temporary increase in the ability of the thyroid gland to collect radioiodine.—*John P. Storaasli, M.D.*

Salter, William T., de Visscher, Michel, McAdams, George B., and Rosenblum, Ira. Changes in blood iodine fractions and radioactivity under therapy. *J. Clin. Endocrinol.*, Dec., 1951, *11*, 1512–1523.

In this paper the authors studied human thyroxine metabolism during the first week after administration of a single dose of I^{131}. Twenty patients were studied; these included some nontoxic goiters, euthyroids, hypothyroids and hyperthyroids. Twelve of these patients were treated with I^{131} ranging from 1 to 49 millicuries. The pick-up of I^{131} in the thyroid was measured in relation to circulating iodide and organically bound iodine, in both stable and radioactive form. These data were augmented by collateral measurements of serum, urine, and exhaled air. The rate of production of radioactive thyroxine was estimated from serial analyses of the blood, for comparison with the functional status of the patient.

The authors conclude that: (1) the functional status of the human thyroid gland was not appreciably altered during the first week after conservative (not over 49 mc.) therapeutic I^{131} dosage; (2) the thyroid clearance was the same as for glands not treated with radioactive iodine; and (3) the thyroxine metabolic turnover rate was the same as with the test doses. Therefore, the authors state that the "test doses of I^{131} afford a reliable preview of the fate of conservative therapeutic doses over a wide range of thyroid activity."—*John P. Storaasli, M.D.*

Sweet, William H. The uses of nuclear disintegration in the diagnosis and treatment of brain tumor. *New England J. Med.*, Dec. 6, 1951, *245*, 875–878.

The author recounts his experience with the Robinson (probe) type of Geiger-Müller counter, utilizing a 2 mm. in diameter cylindrical shaft, which enters the brain to record the beta emissions from P^{32}. From twelve to forty-eight hours after injection there is a 5–1 and sometimes as high as a 100–1 differential absorption of P^{32} by neoplastic brain tissue as compared to normal brain tissue.

The author tells of his experience with the use of a gamma emitter, K^{42}. This has a higher concentration in most brain tumors than I^{131} diiodofluorescein, but has the disadvantage that K^{42} is seized avidly by muscle as well. The temporal and suboccipital muscles, therefore, provide a tremendous background emission field. The upper portions of the skull can be evaluated fairly well. External localization of the brain tumor may be done better by recording of the gamma pair formations by means of the coincidence counting circuit. A more suitable positron emitting isotope is needed for this work.

P^{32} has not been useful in the therapy of brain tumors, due to excessive localization of this substance in the liver and bone marrow. Work is re-

ported with B^{10} which has an enormous capture cross section for slow neutrons. The author found it possible to place as much as 3½ times as much boron in tumor as in normal brain without significant toxic effects. Three times as much radiation was produced in the tumorous as in the normal brain. In some rapidly growing gliomas, the ratio of boron in tumor to that in normal brain is 28:1. However, the concentration is short-lived, extending only for one-half hour after injection. Since B^{10} degenerates with the release of an alpha particle having a path of only 15 microns in tissue, further work is being done to increase the length of time favorable for irradiation by this desirable ionizing agent.—*T. J. Wachowski, M.D.*

Lang, Frederick R. A study of the use of radioactive gallium in medicine. *Ann. Int. Med.*, Dec., 1951, *35*, 1237–1249.

Gallium has several isotopes. Ga^{72} was selected as the ideal of these isotopes for human application. This isotope emits a gamma radiation of 2.53 mev., and a beta radiation of 2.50 mev. It is a rare metal with a low melting point (30° C.), and a boiling point of 1,700° C.

The author, after three years' investigation on animals, proved that the material was safe for human use since neither the inert gallium nor the radioactive isotopes of gallium entered into the active metabolism of the body. Studies in dogs, rats, rabbits and mice showed that if 100 mg. of gallium per kilo of body weight was injected subcutaneously and the animals were killed four hours to 180 days later, the bones picked up by far the greater amount, followed by the kidneys which excreted less than 50 per cent of the gallium content of the bones. In descending order, using the bone content of gallium as 100 per cent, came liver (14 per cent), red marrow (6 per cent), spleen (4.4 per cent) and muscle (1.1 per cent). With dosages approaching the MLD_{50} level some animals did develop albuminuria, casts, and glycosuria. The rabbits excreted 30 to 55 per cent of the total dose in the urine within sixteen hours, while the osteoid tissue absorbed 30 per cent to 48 per cent within the same period. The liver and kidneys fixed small quantities retained in part for more than thirty days. At autopsy no pathological changes in these organs could be demonstrated. Gallium was transported by the plasma but largely disappeared therefrom within twenty-four hours.

Animal studies on the toxicity of gallium showed that: (1) Areas of consolidation developed in lungs of rats exposed to aerosols of the chloride (0.125 mg. per liter in exposures of one-half to four hours). The gallium was deposited in the lungs as the insoluble hydroxide and did not pass the alveolar membrane. (2) Rats fed the chloride or lactate in doses up to 1,000 parts per million of feed developed no effects for periods varying up to twenty-six weeks. Absorption from the intestinal tract was negligible. (3) The minimal lethal doses (LD_{50}) of gallium lactate for rats and rabbits were as follows: (a) rats: intravenous injection 47 mg./kg., subcutaneous injection 131 mg./kg.; (b) rabbits: intravenous injection 43 mg./kg., subcutaneous injection 97 mg./kg. (4) The physical findings and symptoms resulting from near lethal and lethal injections included: (a) loss of weight, (b) hyperexcitability, (c) photophobia, (d) blindness, (e) terminal flaccid paralysis. Early death was due to acute respiratory failure and later some kidney pathology was usually present. (5) The dosage estimated in milligrams per kilo of body weight for use in humans either for tracer studies or for attempted therapy was far below either the toxic or lethal level in animals.

The author uses a diagnostic or tracer dose of 350 to 400 microcuries, but for therapeutic purposes larger doses are necessary. The gallium is flown by airmail from the atomic pile at Oak Ridge and calibrated immediately before administration. It is used in tracer studies within twenty-four hours and for therapy within eight hours of removal from the atomic pile. It is injected slowly into a sterile tube through which normal saline is being given intravenously to the patient. A lead shielded syringe is used. With the aid of Geiger-Müller counters, it was found that 80 per cent of Ga^{72} becomes localized within two hours. In normal bone the localization reaches a maximum within one hour and in bone malignancies within ten hours.

In all cases studied, counts were taken at one minute intervals for the first two hours. Additional counts were made at 3, 10 and 24 hours after injection. Counts were taken over a pattern of 40 standard areas of the human body. Interpretation of radiation was based on the rate of counts per minute per designated area of the body, and rates for each area were compared to an average drawn up for all areas.

So far the author has studied 12 patients with bone metastases from the following primary sites: (1) 6 patients, carcinoma of the prostate; (2) 2 patients, carcinoma of the breast; (3) 1 each, bronchogenic and gastric carcinoma; (4) 1, osteogenic sarcoma; (5) 1, osteochrondrosarcoma. In every instance, tracer studies revealed a high pickup of the radioactivity over each metastatic lesion demonstrated by roentgenographic examination. On several occasions areas of bone with increased radioactivity were found which could not be visualized on the roentgenograms until some time later.

Two patients were subjected to Ga^{72} therapy. A definite relief of pain with prolongation of the useful life was obtained in both. There were no untoward effects.—*Thomas S. Long, M.D.*

Bessler, W., and Meister, Th., Endovesicale Bestrahlung von Harnblasengeschwülsten mit radioaktivem Kobalt. (Endovesical ir-

radiation of tumors of the urinary bladder using radioactive cobalt.) *Schweiz. med. Wchnschr.*, Dec. 8, 1951, *81*, 1214–1218.

The authors, working in the radiotherapeutic clinic in the University of Zurich under the direction of Professor H. R. Schinz, have employed the technique of endovesical irradiation of bladder tumors with Co^{60} in 16 patients. They use aqueous solution of $CoCl_3$ which is placed in the bladder within a rubber balloon. The catheter controlling the balloon has two lumens (Bardex). The one lumen is for the control of the balloon and the other is for urine drainage. The advantage in this sort of procedure is that the radiation emitted is almost pure gamma beyond the walls of the balloon since the beta radiation is stopped by the balloon material. Eighteen to 25 millicuries of radioactive $CoCl_3$ are dissolved in 60 cc. of water for each filling. This produces about 800 to 1,300 r intensity at any point of the surface of the balloon at any time. The half-life of Co^{60} is 5.3 years. The solution can therefore be used repeatedly. As far as the exact statement of the optimum dose is concerned, the authors feel that it is too early for any definite statement. The procedure is too new. The complete adequacy of the balloon system, of course, must be previously ascertained by filling with a radiopaque material. Roentgenograms will then prove that it is intact. The urine can also be tested for the radioactive material during the treatment. The isolation of the patient from other individuals during treatment is advised. A table shows physical measurements at various distances from the patient and with the patient in two positions; measurements have also been made in the adjacent room.

The authors worked with dosages of from 7,000 to 9,000 r at first and have gone as high as 10,0000 to 12,000 r, giving as much as 800 to 10,000 r daily at first and later 1,100 to 1,400 r daily for a period of seven to ten days. They have had some terrific reactions in the bladder, but in 15 patients so treated, there was no tumor demonstrable ten months after treatment. In 2 cases, the reaction was so severe that a check up could not be made by cystoscopy for a month. There was a marked cystitis. One patient has gone ten months, 1 nine months, 1 seven months, 4 five months, 1 four months, 1 three months, and 3 one month without residual tumor. In 1 patient with malignant papilloma with a total dose of 6,400 r, there was bleeding after five months. There was a recurrence in this case. A second dose of 9,310 r was given. A very high grade hemorrhagic cystitis resulted with marked contraction of the bladder.

The authors conclude that the treatment of bladder papillomas and carcinomas with Co^{60} is a worth while procedure, giving better results than the heretofore used therapy. Ten thousand to 12,000 r seems to be the necessary dose for arrest of the tumor. They state that this method of administration allows for a very homogeneous dosage to the inner surfaces of the bladder with a better depth dose to the tumor. The indications thus far are in (1) diffuse benign papillomatosis, (2) residual of a localized papilloma, (3) malignant papilloma with overlying or superimposed bladder carcinoma, and (4) as an adjunct after incomplete removal of a tumor. In tumors difficult of surgical removal at the bladder trigone or about the ostium Co^{60} seems to be the method of choice. Carcinomas with marked infiltration of the bladder wall and adjacent pelvic structures are not suitable for treatment. The authors advise careful observation of the dosage and protective measurements.—*P. C. Swenson, M.D.*

CHEMOTHERAPY

Herráiz Ballestero, Leopoldo, and Rodríguez Fontela, Carlos. Tratamiento del asma bronquial por medio de la mostaza nitrogenada. (Treatment of bronchial asthma by means of nitrogen mustards.) *Prensa méd. argent.*, Nov. 23, 1951, *38*, 3063–3072.

The authors have used nitrogen mustard (hydrochloride of trichlorethylamine) in 19 patients with irreversible asthma with dyspnea of marked intensity. Díaz had previously obtained spectacular results in 8 cases. The rationale is based on experimental evidence of anti-allergic properties of the nitrogen mustards. Dosage was calculated on the basis of 1 milligram per 10 kilograms of body weight, the first dose not exceeding 2.5 to 3 milligrams and never exceeding 6 milligrams.

The results obtained seemed favorable. Subjective symptoms of dyspnea disappeared totally in 13 patients and partially in 2 others. The treatment failed in 4 cases, 2 of whom became worse. Complete functional studies were not obtained in all cases, but those obtained indicated favorable objective signs of improvement in the patients who responded favorably to treatment. The vital capacity was increased in 8 of the 11 patients in whom it was registered. On the other hand, the patients who became worse subjectively, showed worsening of functional studies.—*C. M. Nice, M.D.*

Webber, Banice, Craig, Benjamin R., and Friedman, Nathan B. Cellular dynamics in the intestinal mucosa: quantitative measurements of the effects of nitrogen mustard and irradiation on cellular division and differentiation. *Cancer*, Nov., 1951, *4*, 1250–1258.

A basic cellular cycle in the gastrointestinal mucosa includes division, migration, differentiation, and desquamation. The antimitotic agents such as nitrogen mustard and radiation affect both migration and division but the phase of differentiation is spared as shown by the continuing development of true, mature goblet cells following administration of the above agents.

After single doses of nitrogen mustard or radiation were given to experimental rats, it was found that

mitosis took a decided drop in the subsequent twenty-four hour period. After this, a compensatory hypermitosis was observed, the degree being commensurate with the dose given. In administering two doses of nitrogen mustard or two exposures to radiation, the net result was encountered but modified by the magnitude of the dose and the time interval. Two doses at a twenty-four hour interval resulted in a more prolonged mitotic depression than observed with doses at twelve hour interval. In combining the two agents, the suppression of mitosis was greater than comparable doses of either given individually, and the sequence of irradiation followed by nitrogen mustard had a more severe action than when the agents were given in the reverse sequence. Thus, varying effects may be obtained depending upon the sequence, interval, dose, and agents used.

The authors do not suggest that the same pattern will necessarily be obtained in man. Also, it is questionable what effect is desirable or undesirable. They hope to derive this information from a future study using neoplastic tissue.—*John W. Wilson, M.D.*

Barberio, J. R., Klopp, C. T., Ayres, W. W., and Gross, H. A. Effects of intra-arterial administration of nitrogen mustard. *Cancer*, Nov., 1951, *4*, 1341–1363.

A description is given of the experimental use of intra-arterial nitrogen mustard in the pelvic region in 44 dogs. Various dosage schedules were used. Clinical, hematological and pathological studies were made. The animal experiments indicated that moderate amounts of HN_2 given in periodic injections could be tolerated by the pelvis and pelvic organs. The rectal mucosa showed greater sensitivity than other tissues.

The HN_2 was used intra-arterially in 2 cases of recurrent adenocarcinoma of rectal origin localized to the perineum. Injections were made through polyethylene tubing advanced retrograde into the abdominal aorta from the femoral or external iliac artery. This tubing remained in place for four or more weeks. Blood pressure cuffs placed about both thighs were inflated to above systolic blood pressure during the injections. Comparison of the iliac marrow with the sternal marrow has indicated that the HN_2 action is more marked in the pelvis in clinical patients. One case died and an autopsy was done. The authors state that the other case was started on cortisone and that his subsequent course will be reported later.

The conclusion was reached that the intra-arterial administration of HN_2 caused regression but not eradication of the adenocarcinoma of the rectum in 2 patients.—*W. L. Bridges, M.D.*

Taber, Kenneth W. Treatment of radiation sickness with ACTH; preliminary report of fourteen cases. *Radiology*, Nov., 1951, *57*, 702–709.

The author has used anterior pituitary adrenocorticotropic hormone (ACTH) in 14 cases for the relief of radiation sickness which did not respond to the usual methods of treatment. Since it was thought that these symptoms were caused by intoxication from tissue decomposition products resembling histamine and since some of the antihistaminic drugs such as benadryl and adrenocortical hormone had brought relief to some patients, it was felt that, by stimulating the patient's own adrenal cortex, symptoms might be relieved.

The patients who were submitted to this treatment were those who had received intensive roentgen therapy for several weeks over the torso, and who had become sufficiently ill to warrant ACTH treatment. ACTH was given in 10 mg. doses intramuscularly (this dose is one-half to one-fourth of the minimum amount used in treatment of rheumatic carditis) daily or three times weekly. It was continued until symptoms of radiation sickness disappeared. Roentgen treatments were never decreased nor discontinued during the administration of ACTH. No contraindications to its use were found in this series.

All 14 patients received benefit from these injections. Twelve were relieved promptly after only a few injections while in 1, several relapses occurred, but relief was obtained each time by a few more injections. In the thirteenth patient response was delayed, possibly due to renal complications incident to the primary disease. The fourteenth patient died of his primary disease during this study.

The author also checked the action of ACTH on white mice and found that daily injections for ten days in doses comparable to those given the human beings protected the lives of those mice receiving 300 r of total body roentgen irradiation and prolonged the lives of those which received 600 r.

The results in this small series indicate that ACTH in small doses promptly relieves radiation sickness and that further study is needed to completely evaluate its potentialities.—*D. N. Dysart, M.D.*

Siltzbach, Louis E., Posner, Adolph, and Medine, Myer M. Cortisone therapy in sarcoidosis; effect in a case with virtual blindness. *J.A.M.A.*, Nov. 3, 1951, *147*, 927–929.

A case of sarcoidosis with severe bilateral ocular involvement and enlargement of the mediastinal lymph nodes was treated with intramuscular cortisone for fifteen weeks. There was striking improvement in the ocular manifestation. Mediastinal lymph node shrinkage began on the tenth day and after one month there was only residual enlargement of the lymph nodes at one lung root.

There was no roentgen evidence of recurrence of the lymph node enlargement during the six months of subsequent study.—*C. N. Borman, M.D.*

Lovelock, Francis J., and Stone, Daniel J. Cortisone therapy of Boeck's sarcoid. *J.A.M.A.*, Nov. 3, 1951, *147*, 930–932.

Two cases with well established histopathological, clinical and roentgen evidence of sarcoidosis are reported. Control observation with a two month period of bedrest permitted evaluation of spontaneous regression prior to therapy. Weekly roentgenograms were made throughout the study. Both cases had definite pulmonary and hilar lesions. No regression was noted during the two month period of observation. After cortisone therapy was instituted, there was significant clearing in six days in 1 case and almost complete clearing in the other.

The very rapid clearing of the pulmonary lesions on roentgenograms suggests that very little true organization of the sarcoid process was present. It is conceivable that the pulmonary lesions were of the nature of a granuloma without organization or a purely exudative infiltrate.

The follow-up period, at this writing, is insufficient to permit conclusions regarding the permanency of the beneficial effects. It remains to be seen whether cortisone therapy has altered any fundamental pathological process. No significant toxic effects were noted in these cases.—*C. N. Borman, M.D.*

Small, Maurice J. Favorable response of sarcoidosis to cortisone treatment. *J.A.M.A.*, Nov. 3, 1951, *147*, 932–937.

Three patients with pulmonary sarcoidosis, 1 with associated lymph node and cutaneous involvement as well, were treated with cortisone for periods of four to six weeks.

All showed rapid regression of the pulmonary lesions on the roentgenographic studies, as well as regression of the lymph node and cutaneous manifestations in the 1 case. Clinical improvement was also dramatically rapid. One of the cases, however, in which cortisone therapy was begun on December 18, 1950, developed back pain, and roentgen studies revealed a destructive lesion of the body of the second lumbar vertebra on March 3, 1951. Subsequently, tubercle bacilli were recovered from the genitourinary tract. The danger of the development of tuberculous lesions during cortisone therapy is stressed.

A fourth case is reported in which roentgenographic studies revealed development of a widespread pulmonary fibrosis and bullous emphysema subsequent to a "burnt-out" sarcoidosis. There was a 30 pound weight loss with progressive dyspnea. A disseminated tuberculous process was considered but all laboratory procedures gave negative results. It is believed that in this type of pathologic state cortisone administration would probably not yield any significant therapeutic result.—*C. N. Borman, M.D.*

Tomek, St. Zur Stilbamidintherapie des Plasmozytoms. (Stilbamidine therapy of plasmocytoma.) *Wien. klin. Wchnschr.*, Nov. 23, 1951, *63*, 892–895.

Under stilbamidine treatment basophile granulations consisting of ribonucleinic acid and stilbamidine develop inside the plasmocytes. Their action is thought to be cytostatic. Usually the drug is given intravenously, sometimes intramuscularly with novocain. One starts with 0.05 gm., quickly increasing it to 0.1 and 0.15 gm. for fifteen to twenty injections or gives cycles of ten doses with intermissions of ten days if pains reappear up to a total dose of 3.0 to 5.0 gm. Snapper considers a diet poor in protein necessary, others do not think so. In renal insufficiency Snapper advises the drug to be given on alternating days or twice weekly.

Plasmocytoma recently has been seen rather frequently at the Municipal Sophienspital, Vienna. In 2 cases the clinical effect of stilbamidine could be observed with special attention to precipitation reactions, etc.

The first patient, a woman of seventy-one years, was admitted after a history of one year. Weakness had reached a high grade, anemia was pronounced and pains in the back had rendered her nearly immovable. Roentgen survey showed many small foci of destruction up to lentil size in the skull, slightly fewer in both ilia and isolated ones in both upper femora and the head of the left humerus near its surgical neck. Spine and thorax showed osteoporosis but no foci. There were 1.29 million red cells and 27 per cent Hb., 2 per cent myelocytes, 6 per cent metamyelocytes, 3 per cent eosinophiles and 3 per cent plasma cells. Sternal puncture showed 21 per cent plasma cells. Albumin and globulin values are given. Bence-Jones was strongly positive. Seven blood transfusions in four weeks brought no general improvement, red cells quickly dropped close to 1 million. This stopped with stilbamidine therapy and the anemia improved. After the fourth or fifth injection the patient felt and looked better, pains disappeared completely. The improvement wore off four or five days after the first cycle, but was again seen and continued for a longer time after re-administration. A total dose of 5.8 gm., was given in five cycles from December 1, 1950, to March 21, 1951. In the first two months only two transfusions were necessary per month and later only one. The $beta_1$ globulin decreased from 52 per cent (5.82g%) to 42.6 per cent (4.34g%). Albuminuria decreased from 21 o/oo to 7 o/oo, Bence-Jones also became less. Blood sedimentation rate improved, the Weltmann-band widened from 2 to 4 tubes. The cadmium reaction turned from negative to weakly positive. Plasma cell growth in the uninvolved sternum dropped from 21 per cent to 13 per cent. Granules were noted in 40 per cent of all plasma cells. Roentgenologically there was improvement of the osteoporosis, otherwise no essential change. The patient was released pain free in good condition.

The second case, a woman of sixty-nine, was not

so severe with 2.69 million red cells, 47 per cent Hb., without myelocytes or plasma cells in the blood and 68 per cent plasma cells in the marrow. The roentgenograms showed transparent foci of lentil to hazelnut size only in the cranium, a few of them confluent. The rest of the skeleton was highly osteoporotic especially the thorax; there were numerous incomplete fractures of the ribs. The patient received four cycles of a total of 4.8 gm., stilbamidine. Only after the eighth to tenth injection was there a considerable improvement of the pains. They recurred in the interval with lessened intensity and disappeared with renewed treatment. The general condition, including mobility, showed satisfactory progress. The anemia remained the same. There was no essential change in the distribution of the marrow cells, while the Bence-Jones decreased definitely. After the treatment isolated new foci were seen. The patient was discharged in good general condition.

Most authors agree that there are usually no changes in the roentgen appearance for some length of time, about eighteen months, while in some cases complete recalcification of individual foci is noted.—*H. F. Plaut, M.D.*

Lemon, Henry M., Ravin, Iver S., Ross, Joseph F., Sisson, John H., Anglem, Thomas J., and Branca, A. W. Testosterone therapy of metastatic adenocarcinoma of the thyroid with remission; case report. *Cancer*, Nov., 1951, *4*, 1176–1192.

That the steroid hormones are closely allied to factors which effect neoplastic growth is again suggested by this report of a nine month objective and subjective improvement from testosterone therapy in a case of generalized progressive adenocarcinoma of thyroid. This patient first showed widespread osteoblastic and later a somewhat similar distribution of osteolytic metastases to the skeleton. These caused pain, particularly in the vertebral areas, which was relieved for three months by rather heavy doses of roentgen therapy. Previous to this, there had been very little or no relief with administration of 1 mg. of stilbestrol daily for several months.

There was no significant uptake of radioiodine in the neck or areas of bone metastasis even following stimulation by administration of thyrotropic pituitary hormones. This patient had been followed by numerous observers for a period of nine years. The metastatic areas in the lumbar spine definitely progressed during the administration of roentgen therapy terminating in vertebral collapse.

Testosterone propionate was administered at a dosage rate of 100 mg. intramuscularly three times weekly and continued for the following nine months. There was a dramatic improvement in pain, appetite, and mood within five days of treatment. Narcotics were discontinued and the patient became normally active and gained weight. Dramatic recalcification of many of the bone metastases occurred with almost complete healing in the skull lesions. At the time of this report, the patient was subjectively and objectively well except for a few residual osteolytic areas in the spine and pelvis. Repeat biopsies of the spine still show nests of tumor cells lying in the vascular spaces. Pain has completely disappeared.—*J. A. Campbell, M.D.*

Lindahl, Olov. Tuberculosis of the great trochanter with special reference to the treatment by chemotherapeutics. *Acta orthop. Scandinav.*, 1951, *21*, 221-227.

There were 35 cases (2.65 per cent) of tuberculous involvement of the greater trochanter of the femur in 1,365 cases of osseous tuberculosis treated at St. Görans Hospital in Stockholm from 1940 to 1950. The trochanter was involved solely in 10 cases; in 12 cases the lungs and pleura were also involved; and in 13 cases additional tuberculosis was present in other bones and joints. There was an associated coxitis in 6 cases and spondylitis in 7 cases. Six hundred and forty, or 47 per cent, of the 1,365 cases had spondylitis and 194, or 14 per cent, had coxitis.

Roentgenographic change in the form of osteitis of the trochanter was seen in 25 cases and was absent in 10 cases. Pain and soft tissue swelling occurred regularly. The diagnosis was made by the histopathological investigation in 17 cases, by guinea pig tests and pathologic investigation in 5 cases, and by the clinical course and roentgenograms in the remaining 8 cases.

The spread to the hip joint occurs through bone, soft tissue, or both. In this series, 22 cases treated by operation had fistulous tracts medial to the femoral neck, anterior and posterior, lying against the neck and in some cases extending toward the joint capsule in the hip. The author favors the soft tissue spread as evidenced by this series.

The series was divided into four groups from the point of view of treatment. Eleven cases were treated conservatively with bed rest and plaster casts. Operations were done in 12 cases consisting of removal of tuberculous foci in soft tissues and bone with primary closure. Ten cases were treated by combined surgery and chemotherapy. Two cases were treated by chemotherapy alone. Upon discharge from the hospital, 6 and 3 cases in the first two groups had fistulae and none in the last two groups. There were 4 recurrences in each of the first two groups and none in the last two. The average time under hospital care was 265, 100, 63 and 58 days respectively in the groups.

The present treatment consists of giving 14 gm. of para-aminosalicylic acid daily. Streptomycin 1 gm. and penicillin ½ mill. I.U. is given daily for three days prior to the operation and continued for two to three weeks. After several weeks the operation is performed and the abscesses and sinus tracts are filled with contrast medium and roentgenograms are made in order to localize the process. Streptomycin,

1–2 gm. and penicillin. ½–1 mill. I.U. are placed in the wound prior to closing. A plaster cast is applied for six weeks. Para-aminosalicylic acid is continued for three months after the operation.

The advantages of the combined chemotherapeutic and operative treatment are that the hospital stay is shortened and the fistulae are closed on discharge with diminished risk of infection. The author hopes that further observation will show a reduced frequency of recurrence and less risk of spreading to the hip joint.—*Charles W. Cooley, M.D.*

Gellhorn, Alfred, and Collins, Vincent P. A quantitative evaluation of the contribution of nitrogen mustard to the therapeutic management of Hodgkin's disease. *Ann. Int. Med.*, Dec., 1951, *35*, 1250–1259.

Clinical reports are unanimous in stating that the most satisfactory response to nitrogen mustard (HN_2) has been seen in Hodgkin's disease.

This article gives a critical evaluation of the contribution of HN_2 to the therapeutic management of Hodgkin's disease. The results have been compared in two groups of patients: 67 cases who received radition therapy and HN_2 alternately, and 65 cases who received radiation therapy alone. The evidence shows that the four year survival rate was not significantly different in the two groups, being 48.2 per cent for the former and 47.6 per cent for the latter. Thus, it is concluded that life expectancy is not modified. It was, however, noted that the amount of time necessary for radiation therapy was reduced by one-half in the group receiving both types of treatment.

The incidence of serious toxicity was 7 per cent in 144 courses of HN_2 given to 67 patients. One death occurred in a patient who supposedly had arrested pulmonary tuberculosis which became activated after HN_2 therapy. Whether or not the nitrogen mustard caused the reactivation is unknown. The authors believe that associated tuberculosis is a contraindication to HN_2 therapy.

Immediate subjective and objective improvement followed 78 per cent of the courses of nitrogen mustard therapy.—*I. Earl Holmes, M.D.*

Rosh, Rieva, and Green, George G. Steroids in cancer of the breast. *Radiology*, Dec., 1951, *57*, 837–844.

The treatment of advanced carcinoma of the breast with hormones is reviewd. The authors recommend surgical or radiation castration of women during and up to five years following menarche. For the older age group, treatment with steroids is recommended in conjunction with roentgen therapy of metastasis to bone in weight bearing areas. Androgens are effective in the treatment of some patients with bone metastasis. In the reported series of 50 patients treated with androgens, 51.7 per cent showed subjective improvement and 24.1 per cent showed objective improvement. Those showing subjective improvement were given a course of estrogen therapy with two further cases of objective improvement. Testosterone propionate was injected at the rate of 100 mg., three times a week until a dose up to 7,000 mg. was reached. The series was repeated in a few patients. Time of follow-up has been too short for evaluation of longevity.—*M. B. Goodwin, M.D.*

MISCELLANEOUS

Philbrook, Frank R. Medical problems in radiological defense. *Ann. Int. Med.*, Nov., 1951, *35*, 975–980.

This article reviews some of the medical problems that should be anticipated in event of atomic warfare. Most (about 80 per cent) of the tens of thousands of expected casualties will result from trauma and burns. These will be from the blast effect and the thermal radiation. The other casualties (20 per cent) will be due to ionizing radiation.

Widespread education of the populace is urged, with physicians in key training positions. The author urges that American physicians meet this challenge imposed by the threat of atomic disaster.—*Z. S. Gierlach, M.D.*

Goes, Martin. Statistischer Beitrag zum Sarkomproblem. (A statistical contribution to the sarcoma problem.) *Strahlentherapie*, 1951, *85*, 409–434.

The author reviewed series of sarcomas presented in the literature and 521 cases of sarcoma treated from 1926–1950 in the University Roentgen Institute at Frankfurt am Main. His conclusion that a relationship exists between sarcoma and physical injuries is supported by these observations:

The right side of the body is more frequently affected by sarcoma than the left.

The lower extremities are more frequently affected than the upper.

Males are more often affected than females.

The metaphyses are the sites of greater bending stresses in the growing bones. The distal end of the radius and ulna are exceptions to this rule because of the paucity of muscular attachments there.

Most soft tissue sarcomas appear during the patient's active, "earning" years.

Sarcoma most commonly affects patients in the occupations which require manual labor: farming, and metal, wood, and stone work.—*H. G. Moehring, M.D.*

Wyman, Stanley M., and Scholz, Frank. A preliminary report on radiography in rapid sequence. *Radiology*, Nov., 1951, *57*, 748–751.

In using the various modern techniques of studying the vascular system, a device to enable rapid cassette changing and exposure is needed. Such an

apparatus must fulfill certain fundamental requirements which are: (1) mechanical simplicity, (2) ability to obtain simultaneous sets of roentgenograms at right angles to one another, (3) ability to produce roentgenograms of good technical quality, (4) a rapid and variable rate for making exposures, (5) minimum radiation hazard.

The authors describe an apparatus which does fulfill all the above specifications with the exception of number (2) above.

Basically the apparatus consists of a stack of cassettes between which a strong cord is intertwined. When a motor pulls on the cord the cassettes are pulled up and into position. This action is synchronized with the roentgen timer and switch by various electrical connections.—*McClure Wilson, M.D.*

Wentworth, John H. Use of the nine and one-half-inch roll-film cassette with conventional spot-filming fluoroscopic tables for angiocardiography. *Radiology*, Nov., 1951, *57*, 741–747.

Because of the exacting requirements of angiocardiography and cerebral angiography, many ingenious devices have been developed to produce a rapid series of roentgenograms. The author discusses a few such devices and goes into much detail in describing the construction of a 9½ inch roll-film cassette which was adapted for use with a modern spot-filming fluoroscopic table.

This construction permits taking of exposures in the recumbent and erect positons, permits fluoroscopic control of roentgenographic positioning with a ready chcek on roentgenographic technique and allows good radiation protection for patient and technicians. It is easily adapted to most modern serialographic tables and its cost of construction is not too great.

The reader who is interested in the detailed construction of this apparatus is referred to the original article.—*D. N. Dysart, M.D.*

Fletcher, D. E., and Rowley, K. A. Radiographic enlargements in diagnostic radiology. *Brit. J. Radiol.*, Nov., 1951, *24*, 598–604.

Roentgenographic enlargements to be of value must be free of excessive grain and must have satisfactory definition when viewed at a normal distance. They are particularly valuable in studying the small joints of the hand and foot, and they permit demonstration of some lesions invisible on usual films, as well as more satisfactory demonstration of slight changes seen in an ordinary roentgenogram.

There are two methods available for producing enlargements. The geometrical method makes use of the diverging beam from the target. If the target is small, of the order of 0.3 mm., and the anode-object distance appreciably less than the anode-film distance, enlarged images are produced. The practical limit of this method is enlargement of 2 or 2½ diameters. This permits demonstration of fine detail which would be obscured by the blur resulting from the spread of light from intensifying screens. When the part to be examined can be shown satisfactorily with non-screen films, optical methods are more worth while.

Optical methods depend upon the photographic enlargement of roentgenograms of natural size but having the best possible definition and fine grain. This has been practiced for many years, but the subject material has been very thin sections, and the ultra fine grain emulsions used have required marked exposure increase.

The authors have found that satisfactory enlargements can be made of roentgenograms of the small bones and joints using non-screen films which have been developed in photographic type fine grain developer. Good enlargements up to 10 diameters have been produced. Three important sources of blurring were encountered. One is movement during the exposure, but this was controlled with sandbags. Geometrical blur because of the target size was measured and found to be negligible, even at 8 diameters using a tube with a 2 mm. focal spot. With the usual 1 mm. focus tube this blur is even less. The third type of blur is that due to the double emulsion, but this also was found to be negligible, and, in fact, the contrast increase due to the second emulsion more than offset any disadvantage.

The emulsion used for the most satisfactory studies was fine grain industrial type roentgenographic film. The exposure for the hand was about 800 milliampere-seconds at 45 kilovolts, and development was about ten or twelve minutes. Further slight improvement was obtained by the use of a tube with a molybdenum target which gives off almost monochromatic radiation, but the degree of improvement was slight and the effective dose to the skin was so large that the use of the tube was not felt justified.

Detail studies of metacarpal heads showing osteopetrosis, acromegaly, Paget's disease, and early cortical lesions of rheumatoid arthritis in different patients are presented.—*E. F. Lang, M.D.*

Robbins, Laurence L., and Land, Edwin H. Application of the Land method of film processing in roentgenology; preliminary report. *J.A.M.A.*, Nov. 24, 1951, *147*, 1217–1219.

A new one-step essentially dry photographic process was publicly described in 1947. This paper describes a joint program of investigation into certain roentgenologic applications of this process which utilized the technical facilities of the Polaroid Corporation and the medical facilities of Massachusetts General Hospital.

The Land process utilizes a negative sheet bearing a light-sensitive emulsion and a positive sheet on which the permanent positive roentgenogram is produced. The positive sheet has a special coating which is not sensitive to light. The Land X-Ray Pack con-

sists of a negative and a positive sheet, joined to a common leader. The negative sheet is enclosed in a light-tight black paper envelope to permit handling and loading in daylight.

The processing reagents, in the form of a viscous jelly, are contained in a thin pod attached to the leading edge of the positive sheet. The pod is hermetically sealed, but is so constructed that when subjected to pressure it will burst along one edge and permit its contents to spread between the sheets to form a thin "sandwich."

A special cassette has been developed for this pack and only one intensifying screen is required. After exposure the cassette is placed in a small box, the pack, but not the intensifying screen, is withdrawn from the cassette and passed between motor-driven rolls into a compartment where development takes place. The rolls break the pod causing the reagent to spread in an extremely thin uniform layer between the negative and positive sheets. Processing is complete in one minute after which the sheets are peeled apart, the negative sheet discarded, and the positive sheet, instantly dry, is ready for examination.

Speed is the great advantage of the method, particularly in such procedures as the nailing of hip fractures. The military uses of such a process might be of considerable importance.

Disadvantages are the use of a paper positive print rather than a negative transparency, and the fact that the only size of film pack now available is 9 by 9 inches. The probability is that present limitations will be overcome permitting wider use of what is already a significant advance in processing of roentgenograms.—*A. B. Smith, M.D.*

Smith, Grafton A., Caudill, Carrel M., Moore, George E., Peyton, William T., and French, Lyle A. Experimental evaluation of cerebral angiography. *J. Neurosurg.*, Nov., 1951, *8*, 556–563.

Rabbits were used as test animals to determine if possible the cause of damage if any to the brain following cerebral angiography. Diodrast in concentrations of 70 per cent and 35 per cent was employed, followed by injection of a suitable dye such as sodium fluorescein.

Tests were made to determine the amount of dye retained following diodrast injection.

Diodrast was definitely irritating in 70 per cent concentrations, some batches of the drug were quite irritating while others showed only slight irritation. There was only slight temporary irritation from diodrast in 35 per cent concentration and this cleared in less than three hours.

Clinical studies using the radioactive diiodofluorescein technique before and after angiography have produced the conclusion that even 35 per cent diodrast produces some alteration of the vascular permeability in the human brain.—*V. L. Peterson, M.D.*

Bloor, Byron M., Wrenn, Frank R., Jr., and Margolis, George. An experimental evaluation of certain contrast media used for cerebral angiography; electro-encephalographic and histopathological correlations. *J. Neurosurg.*, Nov., 1951, *8*, 585–594.

The technique employed consisted of the injection of the substance into the carotid artery. Electroencephalograms were taken during the injection and the animal was sacrificed and the brain studied following proper fixing and staining.

Diodrast in 35, 50, and 70 per cent solutions, neo-iopax in 37.5 per cent concentration in Ringer's solution, urokon in 30 per cent at both pH 5.4 and 7.0 and its non-iodinated homologue, prepared in 20 per cent solution and adjusted to pH 7.4; and para-amino-hippuarte in 20 per cent solution were used.

It was noted that the electroencephalographic abnormalities parallel the findings by the dye indicator technique and the pathologic changes. All of the contrast media and their non-iodinated chemical homologues are capable of producing severe abnormalities in cerebral electroactivity and vascular permeability. The severity of injury varies directly with the amount and concentration of the drug administered. Of the media tested, diodrast is the least noxious. On a mg. per kg. basis, a 35 per cent solution is tolerated by rabbits in amounts that are twice the equivalent of that ordinarily used in human cerebral angiography.

The histologic findings indicate a toxic action on the vascular bed producing vasodilatation, alteration of permeability of vessels, and a progressive cerebral edema consequent upon these changes.—*V. L. Peterson, M.D.*

Bacq, Z. M., and Herve, A. Protection of mice against a lethal dose of x-rays by cyanide, azide and malononitrile. *Brit. J. Radiol.*, Nov., 1951, *24*, 617–621.

Many attempts have been made to protect living organisms against roentgen irradiation by pharmacological methods. The authors observed that irradiation of an isolated frog muscle led to a condition simulating oxygen poisoning. For this reason, they investigated poisons which have an inhibitory action on the oxidation systems in the body. Mice were used for these studies.

It was found that cyanides, azide, and malononitrile protect a significant percentage of mice irradiated by a single lethal dose of whole body irradiation. Thiocyanates and cyanates do not protect. Cyanides and the other poisons must be administered before irradiation; injections after irradiation have no effect. Glutathione also protects, and the action of cyanide in protection is enhanced by simultaneous injection of glutathione.

Malononitrile exerts a more powerful protective action than cyanide alone, probably because the cyanide radical is liberated from the former over a

long period while the major portion of the cyanide given as such is rapidly detoxified.

The significant differences in the organs of the protected mice and the unprotected controls are mainly in the liver and adrenals. The lesions in the spleen, bone marrow, thymus, and lymph nodes are about the same whether the animal is protected or not. The exact mechanism of action of the cyanide is not known.—*E. F. Lang, M.D.*

Kaplan, Henry S., and Brown, Mary B. Further observations on inhibition of lymphoid tumor development by shielding and partial-body irradiation of mice. *J. Nat. Cancer Inst.*, Oct., 1951, *12*, 427–436.

In a previous publication, it was reported that mice which developed a high incidence of lymphoid tumors after whole body irradiation are refractory to irradiation localized over the mediastinum, the upper or lower half of the body, or other small areas. These results were considered to exclude the hypothesis that such tumors arise solely as a result of a direct effect of roentgen rays upon a susceptible cell or tissue of origin. It seemed that an indirect mechanism must be operative, either above or in conjunction with a direct effect. This paper presents the results of three recent experiments concerned with this phenomenon. Three related experiments are reported that confirm and extend the evidence that local irradiation is ineffective in the induction of mouse lymphoid tumors and that an indirect systemic mechanism must therefore be implicated.

Experiment 1. One group of mice was given four doses of 300 r each at two week intervals over the upper half of the body only; a second group was given the same dose alternately over the upper and lower halves of the body; a third group received four similarly timed treatments of 150 r each over the whole body; a fourth group was treated like the third except that the mediastinal area was shielded with lead; and a fifth group was kept as an unirradiated control. Lymphoid tumor incidence after sixteen months was, respectively, 8 per cent, 8 per cent, 52 per cent, 0 per cent and 8 per cent.

Experiment 2. Fractionated alternate irradiation of the upper and lower halves of the body at intervals of 0, 1, 6, and 24 hours yielded lymphoid tumors in 69, 74, 70 and 53 per cent of the respective groups. This response was almost identical with that of mice receiving equivalent whole body irradiation. Only 1 of 56 mice (2 per cent) receiving alternate half-body treatments at four day intervals developed a lymphoma.

Experiment 3. This experiment was intended, in part, to study the effect of preserving ovarian function. The ovaries were transplanted to the muscles of the right hind leg in Groups I and II and left intact in Group III. During irradiation, mice of Group I were unshielded while those of Groups II and III had a lead shield placed over the right hind leg. Lymphoma incidence to date has been 44 per cent, 10 per cent and 10 per cent respectively.

Experiment 1 confirms the observation that local irradiation is ineffective in inducing lymphomas, and further shows that discrepancies in volume dose are not responsible for this lack of effect. In Experiment 2 the results suggest that the additivity of the effects produced in the two halves of the body is dependent on a labile factor from which the animal is able to recover in an interval of between 24 and 96 hours. This labile response is hypothetically consistent with the release of a transient humoral material necessary for tumor induction. Further support of the theory that a humoral factor is released by irradiated tissue, but destroyed or inactivated by nonirradiated or radiation recovered tissue, is found in Experiment 3.

A number of factors such as genetic constitution, age, endogenous and exogenous endocrine stimulation dose, technique of administration of leukemogenic agent, and shielding have been shown to influence the lymphoid tumor induction process. Lymphoid tumor development is dependent upon the attainment of a threshold state in the lymphoid tissues, and this threshold is governed by the physiologic attributes of genetic constitution, and by hormonal influences. In a particular strain of mice this threshold may be exceeded by the additive effects of any agent, as well as by the additive and synergistic effects of two or more agents. Shielding might reduce the intensity of the agent, while testosterone administration might act by elevating the threshold or by reducing the susceptibility of lymphoid cells to the direct effects of the agent. Conversely, a strain in which the threshold is intrinsically low might develop lymphomas after mild stimulation.—*Thomas S. Long, M.D.*

Lindemann, Bruno. Die Röntgenhämolyse, ein Beitrag zur biologischen Wirkung ionisierender Strahlen. (Roentgen hemolysis; a contribution to the biological effect of ionizing radiations.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Nov., 1951, *75*, 521–559.

This important report is the contribution of one of Herman Holthusen's pupils to a special edition in honor of the 65th birthday of his great teacher.

The use of the electron microscope in studies of hemolyzed erythrocytes has greatly advanced the knowledge of the structure of these cells. The author presents the results of such studies. The contents of erythrocytes can be lost either by diffusion through the cell membrane or by destruction of the cell structure. The former takes place in water or hypotonic salt solutions and is called osmotic hemolysis. Roentgen hemolysis is a colloid osmotic hemolysis which is due to a change of permeability of the cell membrane produced by irradiation. Structural studies of such cells with the electron microscope show

that these changes in membrane permeability are due to a primary denaturation. The radiation hemolysis depends upon the speed of reaction between the hemolyzation and the membrane, upon the speed of the penetration of the salt and upon the speed of the disintegration of the cellular content; the last is the most important. Electron microscope studies have further demonstrated that denaturations produced by either a large variety of physicochemical agents or by irradiation lead to alterations in the cell membranes which are morphologically analogous. Plasma suspensions hemolyze to a lesser degree than plasma free suspensions under otherwise identical conditions. One may therefore conclude that the denaturation of the membrane by irradiation is due to an indirect effect.

The wide physiological range of reactions of a suspension of erythrocytes is probably due to two processes which run parallel, namely the biological variability due to age of the cells and the protective effect of an aggregation of cells. Interpretation of roentgen hemolysis by means of the target or "treffer" theory has not yielded satisfactory results and various reasons for this fact are given.

A large number of excellent electron microscope pictures of normal and damaged eyrthrocytes accompany this outstanding paper.—*Otto Glasser, Ph. D.*

Van Ordstrand, H. S. Current concepts of beryllium poisoning. *Ann. Int. Med.*, Dec., 1951, *35*, 1203–1217.

Since 1940 the author has studied 450 persons with beryllium poisoning, one of the newer industrial diseases. The effects of the intoxication are systemic although the presenting symptoms are acute or chronic dermal eruptions and/or acute or chronic respiratory symptoms. The most common lesion is an acute eczematous contact dermatitis. Indolent type of ulcers over knuckles from the implantation of beryllium in an abrasion as well as chronic granulomata arising in lacerations produced by broken beryllium oxide fluorescent lamps occur. Both the latter lesions are local and curred by excision.

Ninety-eight cases of beryllium pneumonitis, 12 fatal, have been seen. The onset is with a nonproductive cough and dyspnea of two to three weeks' duration before symmetrical nodular pulmonary infiltrations are seen roentgenographically. Decreased liver function and hyperglobulinema are present. Death is from asphyxia with or without acute cor pulmonale. Pathologically, an intra-alveloar edematous exudate with a mononuclear reaction and occasionally central liver necrosis is seen.

Symptoms in "chronic berylliosis" may be delayed as long as ten years following exposure. Often the roentgen findings are positive before symptoms occur. As in the acute form, but less rapidly progressing, symptoms of cough, dyspnea, anorexia and weight loss are present. Some patients may have fever. The mortality rate is greater than in the acute form, representing nearly one-third. Roentgen examination shows disseminated pulmonary nodulation; and death is due to cor pulmonale. In this chronic form of the disease, beryllium has been demonstrated in the liver, lymph nodes and renal calculi.

No specific antidote has been found. ACTH and cortisone have produced encouraging results in the chronic form.

By suitable measures beryllium poisoning is being eliminated as an important industrial hazard.—*Lawrence A. Pilla, M.D.*

Gárciga, C. E. A new radiolaryngometric method. *Radiology*, Dec., 1951, *57*, 884–885.

A device is described which has proved useful in localizing desired areas of the larynx more exactly so that laryngeal lesions may be accurately irradiated over the smallest possible area.

A square made of lucite is marked off at distances of 1 cm. by fine lead lines and over one of its bars a ruler, which is similarly marked, slides from side to side parallel to the axis of the neck. The square is fastened to the neck and the ruler is so placed that its margin coincides with the anterior border of the larynx. Marks are made on the skin corresponding to the lead marks on the apparatus. A lateral roentgenogram is then made and the location of the lesion determined in relation to the marks on the skin. In this manner, the area to be irradiated can be accurately outlined on the skin.—*McClure Wilson, M.D.*

Riebel, Frank A., and Carroll, C. C. An adaptometer for preparation for fluoroscopy. *Radiology*, Dec., 1951, *57*, 882–883.

This adaptometer is used to judge one's readiness to conduct fluoroscopic examination. There are five self-luminous segments, recessed in a rotating circular backplate, made visible by phosphorus excited by the beta radiation from C^{14} and having surface brightness varying from 0.60 to 0.0026 microlambert. A brighter red fixation point is placed above the luminous window. Due to disk phosphorescence, the shutter must be closed when the instrument is in light to avoid false readings.

The instrument is free of any dangerous radiation hazard.—*Dean Nichols, M.D.*

Zuppinger, A., and Seemann, E. Zur Technik der Thorax- und Herzaufnahme. (On the technique of chest and heart roentgenography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Dec., 1951, *75*, Supp., 183–189.

A comparative study of a series of roentgenograms of the same patient is inadequate if not impossible because of the variation in technical factors as well as changes in the size of the heart and hilar vessels. The authors have devised an apparatus which

synchronizes the exposure with the cardiac phase or the carotid pulse. Schematic diagrams are included in the article. The actual operation is much simpler than the description and can be mastered easily by a technician.—*Joseph Zausner, M.D.*

Sarnat, Bernard G., and Engel, Milton B. A serial study of mandibular growth after removal of the condyle in the macaca rhesus monkey. *Plast. & Reconstruct. Surg.*, May, 1951, *7*, 364–380.

The purpose of this study was to determine the effect of surgical removal of one or both condyles of the immature mandible. The rhesus monkey being the only readily available animal with a facial structure closely resembling man's, 10 eight month old monkeys of this species were used. Five served as controls. In 2 animals the right mandibular condyle was resected, and in 3 animals both condyles were resected. Roentgenographic examinations were done one week preoperatively, immediately after surgery, and at six month intervals subsequently. Also casts were made from the teeth and jaws at regular intervals. The postoperative survival period ranged from four to seventeen months. The heads of the dead animals were dissected and photographed.

Removal of a condyle was not followed by ankylosis. A false joint developed and provided good mandibular function. However, the condyle is evidently an important growth center because after its removal vertical growth of the ramus ceased. This resulted in asymmetrical deformity when one condyle was resected, and symmetrical deformity when both condyles were removed.

The importance of the growth center role of the condyle should be kept in mind when the question of surgery in the neighborhood of the temporomandibular joints of children arises.—*George Cooper, Jr., M.D.*

Dobyns, Brown M., and Lennon, Beatrice. A study of the behavior of human thyroidal tumors transplanted into the anterior chamber of the guinea pig's eye. *Ann. Surg.*, Dec., 1951, *134*, 984–998.

Thyroid tumor tissue from 23 different patients was transplanted into the anterior chamber of the eyes of guinea pigs. Only the highly malignant tumors grew perceptibly and then only after a latent period of several months. The remainder of the tumors were either absorbed or remained viable without increase. In several instances this surviving fragment of tissue still consisted of tumor cells after periods longer than one year. In some instances morphologic differentiation took place in the transplants. The presence of acini containing colloid was observed but tests with radioactive iodine gave no uptake in these foci.

This technically difficult study has thrown some new light on the problem of evaluating different types of thyroid growths.—*J. W. Turner, M.D.*

Goldfeder, Anna. Further studies on the radio-sensitivity of the analogous mouse mammary tumors dbrB and C_3H. *Radiology*, Dec., 1951, *57*, 845–863.

Two analogous breast adenocarcinomas of mice, namely dbrB and C_3H, are investigated thoroughly with respect to their rate of growth and their intermediary metabolism in vivo. In vitro, tumor dbrB grows and metabolizes more rapidly and is destroyed by a smaller dose of roentgen rays than is tumor C_3H. In vivo, both tumors are destroyed by lesser doses of roentgen rays, but tumor C_3H requires only 8,000–12,000 r (single dose measured in air) whereas tumor dbrB requires 16,000–24,000 r of the same type of radiation. Clinically, tumor dbrB is much the faster growing tumor in vivo.

To determine comparative growth rates on a laboratory basis in vivo, Chaulkley's method of analysis of spatial distribution was used to determine a "mitotic index," and values of phosphorylated intermediates were determined biochemically from fresh, frozen in vivo tumor tissue. These methods correlated with the clinical findings, showing that tumor dbrB was the faster growing tumor in vivo, in spite of its relative radioresistance.

From mitotic indices determined at varying times following sublethal irradiation, it was found that the faster growing tumor recovered more rapidly. It is suggested that increased circulation carrying off toxic products from the more rapidly growing tumor might be a factor in its early recovery. The effect of irradiation upon the phosphorylated intermediates is much less than that on the mitotic index. There was little difference between the two tumors except that the adenosine triphosphate content of the dbrB tumor was more markedly affected by lethal radiation (30,000 r) than that of the C_3H tumor (12,000 r). Otherwise, the amounts of the eleven compounds determined in both tumors were relatively unaffected by lethal irradiation, even though the cells eventually died, showing that lethal irradiation has little effect on the metabolism of the malignant cells.

The foregoing findings are contrary to the Bergonié-Tribondeau law of radiosensitivity, and the author suggests that our criteria for radiosensitivity and forms of radiation therapy should be re-evaluated. She suggests that much larger doses through much smaller portals should be used and reports the successful destruction of a radioresistant mouse mammary adenocarcinoma using a total dose of 24,000 r without injury to the rest of the animal organism and practically no evidence of radiation sickness. She also suggests that further work be done with Jolles' modification of Grynkraut's grid in order to minimize skin reaction and radiation sickness from larger portals.—*M. B. Goodwin, M.D.*

Hollcroft, Joanne Weikel, and Lorenz, Egon. The 30-day LD-50 of two radiations of different ion density. *J. Nat. Cancer Inst.*, Dec., 1951, *12*, 533–544.

The effect of radiation quality on biologic response has long been the subject of much discussion and investigation. A qualitative difference in the biologic effect of the different types of radiations cannot be expected. However, a quantitative difference caused by the different specific ionizations of the various radiations can be expected. When a single ionization is sufficient to kill a cell or organism, roentgen radiation will be more efficient than α-radiation but when a number of ionizing events are necessary to produce a change, the densely ionizing particles are more efficient. A change produced by a single ionization event would be expected to be independent of the dose rate whereas the change produced by several ionization events should be dependent on the dose rate for roentgen radiation and also for α-radiation when the number of ionizations per particle is less than that required to produce the change.

In vitro studies on destruction of tumor tissue show that roentgen radiation is 50 per cent more effective than α-radiation and that neutrons (ion density about 300 ions per micron) are 2 to 3 times more effective than roentgen radiation. Moreover, neutrons with 1,500 ions per micron were found to be 24 times more effective than α-radiation in destroying tumor tissue in vivo, and 9 times more effective in vitro. This may indicate a response of the animal body to the irradiation, which increases with ion density. Hence, the relative effectiveness of acute irradiation by roentgen and α-radiation in killing the whole animal was investigated by means of two experiments.

In the first experiment five groups of male mice were injected intravenously with an aqueous solution of radon, the doses ranging from 0.013 mc/gm. to 0.017 mc/gm. or expressed in energy absorbed 33,800 ergs/gm. to 44,200 ergs/gm. Eight groups of mice of the same strain and age were exposed to doses of roentgen radiation ranging from 480 to 645 roentgens or 44,600 ergs/gm. to 60,000 ergs/gm. The dose rate was graduated by addition of aluminum and copper filters to simulate the dose rate of the radioactive material injected intravenously. The 30-day LD_{50} was calculated for the two radiations.

It was found that the percentage mortality increased rapidly with dose in the case of the radon treated animals but more slowly in the roentgen irradiated animals. The roentgen radiation 30-day LD_{50} was found to be 564 r or 52,400 ergs/gm.; for the radon solution it was 0.01415 mc/gm. or 36,800 ergs/gm. The roentgen-ray energy absorbed was therefore 1.42 times that of the α particle energy absorbed.

To determine the distribution of the tissue dose in the radon treated animals a second experiment was carried out. An aqueous solution of radon was injected intravenously into approximately 300 mice and 3 to 9 mice were killed at specific time intervals. The various tissues were separately examined and the dose was calculated for each tissue from the radioactive content. These doses were compared to the average dose or the expected roentgen radiation dose. In addition, the proportionate tissue weights were found and used to calculate the total radioactive content of the tissues and the total energy absorbed in a 25 gm. mouse. As expected, a great difference in dose to various organs was found. The total absorbed energy was calculated to be 1.04 times 10^6 ergs for a 25 gm. mouse which corresponds to 450 r of roentgen radiation.

The authors conclude that "the LD_{50} as found in our experiments seems to depend upon the total number of ionizations, regardless of distribution, and not on specific ionization. The discrepancy between the finding and those on small biologic entities in which specific ionization plays an important role may perhaps be accounted for in the following way: In small biologic entities (such as bacteria, spores, seeds, and cells in cell culture), the primary effects of irradiation seems to be responsible for irradiation injury or death. In whole animals like the mouse, it is not the primary effects, which disappear rapidly, that cause the ultimate establishment of the injury but the systemic secondary reactions provoked by the sum of the primary effects."—*L. K. Sycamore, M.D.*

Spargo, B., Bloomfield, J.R., Glotzer, D.J., Gordon, E. Leiter, and Nichols, O. Histological effects of long-continued whole-body gamma-irradiation of mice. *J. Nat. Cancer Inst.*, Dec., 1951, *12*, 615–656.

To study progressive stages in the development of irradiation injury during long-continued exposure to gamma radiation, the authors conducted experiments on hybrid mice from the stock of the National Cancer Institute. Exposure of the animals was begun at the age of two months at each of three dose levels: 1.1, 4.4 and 8.8 r daily (8 hours). Nonirradiated controls were used as a standard. Four male and 4 female mice of each dose level were killed and autopsied at intervals of approximately two months up to sixteen months. Comparative observations were made on specific tissues.

In the thymus gland these doses of chronic gamma irradiation produced an increase in the number of mast cells and a decrease in the number of lymphocytes in both cortex and medulla. Both changes began at ten months with 1.1 r daily (8 hours); at eight months with 4.4 r daily (8 hours); and at four to six months with 8.8 r daily (8 hours). Lymphocytic regenerative attempts were present at fourteen and sixteen months in the animals exposed to 1.1 r and 4.4 r daily (8 hours). In the latter group the destruc-

tive and regenerative tendencies were more closely balanced. Histologically, lymphocytic regeneration seemed to merge into lymphoma in some of the older animals receiving 8.8 r daily (8 hours). Sex differences were not observed.

Changes in the spleen consisted in an increase in the number of mast cells, increase in the proportion of white pulp, and increase in erythropoiesis. These changes were noted only at the two higher dose levels and began earlier and progressed farther in proportion to the size of the dose.

The changes in the bone marrow included a gelatinous replacement of the cellular marrow, especially in the metaphysis, a progressive increase in the number of mast cells and, at the highest dose level, an increase in the number of hemocytoblasts. The extent of these changes was greater with 8.8 r than with 4.4 r and with duration of treatment. No changes were seen after 1.1 r daily (8 hours).

In mesenteric lymph nodes changes were observed only in the animals irradiated with 8.8 r daily for ten to sixteen months. In the lymph nodes of these mice there was a decrease in the number of small lymphocytes in both cortex and medulla and in the number and size of lymphocytopoietic centers as well as of cortical sinuses packed with small lymphocytes.

In the peripheral blood the total leukocyte and lymphocyte counts were significantly depressed only in the 8.8 r groups. This depression was established early and maintained throughout the experiment. The red blood cell counts and hemoglobin values were reduced only in animals exposed to 8.8 r daily for about a year.

In the testes the irradiation at the rate of 1.1 r daily caused no changes. With 4.4 r daily there were slight degenerative changes up to ten months of irradiation. The same dose for twelve to sixteen months caused progressively increasing degeneration. The rate of 8.8 r daily produced considerable generalized degeneration after treatment for two months. Inhibition of spermatocytogenesis rather than destruction of spermatogenic elements appeared to play the more important role in causing the depletion of the spermatogenic elements.

In the ovaries changes were qualitatively the same at the three dose levels and quantitatively depended upon the total amount of radiation. Primitive ova degenerated and disappeared, larger growing follicles became atretic and finally disappeared, small nests of lutein cells appeared first at the periphery and then spread through the ovary, and tubular downgrowths from the germinal epithelium appeared and grew irregularly throughout the entire ovary. The number of cysts was increased over those in the controls but no other ovarian tumors developed.

The gastrointestinal tract, skin, liver, kidney, adrenal glands, pancreas, heart, and lungs showed no deviations from the normal.

With regard to tumor formation, this strain of mice was susceptible to spontaneous lung adenoma and the incidence of this tumor increased in the irradiated animal in proportion to increased dosage. Ten hepatomas occurred in the treated animals as well as five other tumors of various types.

No lymphoma occurred in the control animals. There were twelve obvious leukemias in 192 irradiated animals, the incidence increasing in proportion to the intensity of the irradiation.—*L. K. Sycamore, M.D.*

Berenbom, M., and White, J. Metabolism of N^{15}-labeled-dimethylaminoazobenzene in rats. *J. Nat. Cancer Inst.*, Dec., 1951, *12*, 583–590.

The experiments reported were designed to obtain quantitative data on the fate of DAB nitrogen in the rat. Three preparations of DAB were used, each labeled with N^{15} in a different position. Rats were placed on the DAB diet used for the routine production of primary hepatomas. The N^{15}-labeled DAB was administered by stomach tube and then urine, feces, and various tissues were analyzed for total nitrogen and N^{15} concentration. The three preparations of DAB used were called in the article DAB-1, DAB-2, and DAB-3, according to the N^{15} position in the molecule.

After a single dose of N^{15}-labeled DAB significant amounts were found in the gastrointestinal tract and the liver. The average total recovery of administered N^{15} in the urine, feces, gastrointestinal tract, and liver, was 88–93 per cent at 24 hours and 92–98 per cent at 72 hours.

To determine the effect of continuous feeding of DAB on the excretion pattern of DAB nitrogen, rats were placed on a diet containing unlabeled DAB and at various intervals were given by stomach tube a single dose of 6.0 mg. of isotopic DAB. It was found that continuous feeding of DAB over a four month period did not alter the general excretion pattern of DAB nitrogen.

The amount of N^{15} in the liver following a single dose of N^{15}-labeled DAB was small, being somewhat larger when DAB-2 and DAB-3 were given than when DAB-1 was given. Prolonged feeding, on the other hand, resulted in a much higher N^{15} concentration in the liver than was obtained with a single dose.

Thus the very great excretion of DAB nitrogen and the very small amount found in the liver may, in part, explain the necessity for continuous feeding of this compound for the production of tumors. The small amount of DAB nitrogen present in the liver indicates that only a small fraction of the DAB or derivatives thereof is intimately associated with the tumor-producing process. Since there is greater retention of the N^{15} of DAB-2 and DAB-3 than of DAB-1 this suggests that in the degradation of DAB in the organism the fractions derived from the diamine half of the molecule are held more firmly in the liver than those of the aniline half of the molecule.—*L. K. Sycamore, M.D.*

WIDERÖE, R. The 31-mev. betatron (ray-transformer). *Brown Boveri Rev.*, Sept.-Oct., 1951, *38*, 260–272.

The author discusses in extenso the principle and design of the 31 mev. betatron which was manufactured by the Brown, Boveri and Company, Limited, Baden (Switzerland), for the use of the Radiological Institute of the University of Zurich under the Directorship of Prof. H. R. Schinz.

The unit is installed at the Cantonal Hospital in Zurich. It differs from other similar apparatus in that it was constructed for dual-beam operation. This was accomplished by mounting two electron guns, one at each end of the diameter of a toroidal tube, which inject electrons in opposite directions and at periods in the magnetic cycle separated by 180° in phase. As a result the accelerated electrons, on impinging on the target, produce roentgen rays to the right and left alternately, giving rise to two opposite beams which are emitted 180° apart spatially. It may be mentioned that the two electron guns, and thus also the two roentgen-ray beams, can be adjusted independently.

The following are some of the notable features of design: The magnetic circuit is of the radial-laminated type with laminations welded together on the external surfaces of the core. Strong cast-steel parts press six yokes laterally on the core, which can readily be removed on rollers, enabling replacement of the cathodes of the toroidal tube within a few hours. A special arrangement is provided for additional orbit expansion and, thus, variation of the radius of the electron orbit. The toroidal tube has two arms for the electron guns and a third containing a continuously heated getter material with a high gas absorption capacity; its interior is lined with a conductive coating for capture of the stray electrons. The target is located in one of the electron guns and consists of a small piece of platinum only 1.5 mm. thick placed in the direction of incidence of the electrons. The axes of the two roentgen-ray beams practically coincide with the direction of impingement of the electrons on the target. Since both beams are very narrow (falling to half intensity at 3.3° from center) the collimators limiting the field of irradiation had to be arranged very carefully. The collimator insert is forced into the conical aperture of the collimator block, both being made of a mixture of lead powder and synthetic resin. Interchangeable treatment cones can be fixed on the collimator inserts and an aiming device permits an accurate measurement of the distance up to about 1.6 meters from the target. The whole set rests on four rollers so that it can easily be moved to any desired position. The transverse axis of the toroidal tube is located 120 cm. above the floor level.

The author also describes at length the mode of injection of the electrons and its effect upon the subsequent expansion of the electron orbit. Finally, he gives a comprehensive analysis of the properties and application of the roentgen rays produced.

The article is richly illustrated with diagrams, photographs and numerous graphs. A composite graph embodies the depth dose curves of ionization intensity in water for the ordinary 200 kv. roentgen therapy, and the 1.5 mev. (Bergen), 22 mev. (Saskatchewan) and 31 mev. (Brown Boveri) betatron roentgen therapy.—*T. Leucutia, M.D.*

VON ARX, A. The 31-mev. betatron installation at the University Radiological Institute attached to the Zurich Cantonal Hospital (Prof. H. R. Schinz). *Brown Boveri Rev.*, Sept.-Oct., 1951, *38*, 273–280.

The apparatus described in the forementioned article was installed in the University Radiological Institute attached to the Zurich Cantonal Hospital during the winter of 1950–1951 and has been used since April, 1951, for the treatment of 40 cancer patients.

In the present article the author describes in detail the layout of the installation, using several photographs to illustrate the salient points. He states that the plan was governed to a large extent by the fact that in addition to the arrangement for clinical therapy, provisions had also had to be made for experimental biological and physical investigations and for industrial roentgenography. For this reason, and to enable better protection facilities, the apparatus was placed in the basement of the Institute, amply separated from the remainder of the Clinic.

The betatron itself is located between two treatment rooms and is rather snugly enclosed to allow a minimum target-skin distance of 75 cm. either way. It weighs, together with the lead screening plates, approximately 5.5 tons and is mounted on wheels so that it can be moved into the larger adjacent treatment room for change of the used cathodes of the toroidal vacuum tube (which usually has a life of about 1,000 hours). The dismantling of the betatron, the replacement of the electrodes and the re-assembly operation ordinarily take three hours; however, since slight modification of the magnetic conditions may occur, two days may elapse before the apparatus can be put back in full operation.

The protective measures which had to be incorporated to safeguard the personnel working in the adjacent rooms or neighboring area, and even the patient undergoing treatment, from direct and indirect exposure are discussed. Since the radiation emerging from the body of the patient still represents 50 per cent of the incident intensity, openings called "radiation traps" are provided in the opposite walls to capture part of this radiation. A twofold safety system is also provided for the prevention of high voltage hazards.

The intensity of the beam is measured by an ionization chamber which is mounted slightly away from

the defined main beam. This chamber consists of three parallel plates, the middle plate being charged to 300 v compared with the two outer plates. A Victoreen condenser-type of ionization chamber, likewise placed just off the main beam, is used for control.

The irradiation is carried out at skin-target distances of 75 to 100 cm. Six different collimator inserts have been provided for each beam of the betatron. To each of these inserts two types of treatment cones can be attached increasing the distance. Thus twelve cones of circular and rectangular shape are available for each beam, permitting the treatment of areas of from 7 to 314 cm.^{2} in size. Equalizing filters composed of a mixture of copper powder and synthetic resin are fitted in front of the collimator insert to obtain uniform intensity over the irradiated area. At the present time doses of 300 r are given per treatment, requiring an exposure time of four to fifteen minutes, depending on the field size and skin-target distance.

In experimental investigations the object to be irradiated may be placed at the exit of the beam from the high vacuum tube, that is at a distance of only 14 cm. from the target. At this point the output is 4,000 r per minute.

In concluding, the author states that during its first five months of operation, the 31 mev. betatron has come up to all expectations and has met even the most exacting clinical requirements for a seven hour daily service.—*T. Leucutia, M.D.*

Joyet, G., and Mauderli, W. Adaptation of 31-mev. betatron to medical applications, and shielding problems. *Brown Boveri Rev.*, Sept.-Oct., 1951, *38*, 281–291.

This is a contribution from the Betatron and Isotope Laboratory of the Radiotherapeutic Clinic (Prof. H. R. Schinz) of the University of Zurich.

The authors first discuss the absorption of roentgen rays in matter by weighing the relative importance of the photoelectric effect, the Compton effect and the electron-positron pair production at various energy levels.

Then they consider the action of roentgen rays of different energies in living tissues by paying special attention to the ratio of depth and skin doses with conventional and betatron therapy and to the so-called "transition curve" at 31 mev. This latter term is used in place of "depth-dose curve" to express the fact that, owing to the great range of the secondary electrons at energies of several tens of millions of electron volts, the skin intensity represents a minimum rather than a maximum value and consequently a rise in the depth dose occurs until the transition reaches its peak at a depth corresponding to approximately the mean range of the electrons. After that there is a gradual fall in the depth dose. The authors studied the "transition curve" at 31 mev. on a plexiglas phantom of 1.18 specific gravity and determined its shape for distances of 75, 100 and 130 cm. from the target. The measurements were carried out by means of a Victoreen condenser-type r-meter and the results obtained were found to be in agreement with those obtained by Johns, Darby, Haslam, Katz and Harrington (see this Journal, 1949, *62*, 256–268). They have also determined the variation of the transition curve with the angle of the beam aperture by employing 3 fields (of 4, 8 and 20 cm. diameter) at a distance of 100 cm. from the target and a different thickness of equalizing filter for each field. It was possible to obtain a forward displacement of the peak of the curve from 4.8 cm. with a 20 cm. diameter field to 6.2 cm. with an 8 cm. diameter field solely by changing the thickness of the filter.

Finally, the authors describe the procedures they use for positioning the patient, for measuring the dose administered, for shielding against radiation hazards (of both the patient and the operator) and for superivising the patient during treatment. Numerous diagrams, tables, curves and photographs are included for illustration.—*T. Leucutia, M.D.*

Watson, T. A., and Burkell, C. C. The betatron in cancer therapy. Part II. *J. Canad. A. Radiologists*, March, 1952, *3*, 25–28.

The first part of this article dealt with the physical aspects of the 22 mev. betatron roentgen therapy as applied at the University of Saskatchewan, Saskatoon (see former abstract in this Journal).

In this present second part the authors give a detailed account of the clinical results obtained thus far. Altogether 58 patients were treated of whom 10 had carcinoma of the cervix, 9 carcinoma of the bladder, 10 carcinoma of the lung, 8 carcinoma of the rectum, 6 brain tumors, 4 carcinoma of the esophagus and 11 miscellaneous malignant neoplasms. Of the 58 patients, 26 are alive for periods ranging from four to seventeen months after completion of treatment and 32 are dead. It must be mentioned that practically all patients had very advanced lesions for which conventional roentgen therapy would have been of little or no value.

The technique of irradiation for each of the forementioned groups is described in short résumés. Mostly rectangular fields 8 by 10 cm. and 10 by 15 cm. in size and, less frequently, circular fields of from 6 to 15 cm. in diameter were used. The tumor dose varied with the type of neoplasm and duration of treatment.

The authors state that 22 mev. betatron roentgen therapy does not appear to have any obvious biologic specificity when compared with conventional roentgen therapy but it does present certain physical attributes which may be used to advantage. Thus, the lack of variation of depth dose with field size and the relatively flat isodose curves (with the use of

a suitable compensating filter) permit great simplification of technique. Skin reactions, even with high tumor doses, are negligible and, owing to the low integral dose, constitutional effects are minimal. The best immediate response was obtained in carcinoma of the cervix and bladder although local recurrence ensued in many of these cases, indicating that a tumor disappearance rather than a tumor lethal dose was given. When higher doses were attempted, the effect on the bowel and bladder proved to be a limiting factor. A tumor dose of 6,000 r delivered to the whole pelvis in three weeks was found to be the maximum allowable. With smaller volumes the tissue tolerance dose is somewhat higher. In advanced carcinoma of the lung and in brain tumors, considerable palliation was obtained. Carcinoma of the rectum, on the other hand, has shown a very poor response.

The conclusion is reached that 22 mev. betatron roentgen therapy is a practicable mode of treatment in cancer. No unexpected deleterious effects have been observed.—*T. Leucutia, M.D.*

LARKS, S. D. Stray x-rays from electron beam instruments and some biological implications. *Am. Indust. Hyg. Assoc. Quart.*, Dec., 1951, *12*, 4.

The author calls attention to the fact that at the present time electron-beam instruments of many types are in use which may constitute potential or actual sources of stray roentgen radiation. This is understandable since there is a close similarity between the construction of certain electron-beam instruments and the ordinary roentgen tube. In both instances, a beam of electrons is propelled forward in an evacuated tube by an accelerating potential. In a roentgen tube this accelerated beam impinges upon a metallic target whereas in a typical electron-beam instrument the "target" is replaced by a fluorescent screen.

The author has conducted survey work with the purpose of localizing possible sources of stray roentgen radiation in conjunction with two rather commonly used electron-beam instruments, the industrial oscillograph and the electron microscope. The data obtained are presented in this paper.

As regards the industrial oscillograph, it was already noted on preliminary investigation that the radiation level in the entire area surrounding the instrument was many times above that of the normal background. On closer study it was found that the heaviest radiation was emerging from the vicinity of the electron gun, particularly from several rectangular openings of the metal housing, and from the glass wall of the discharge tube. Roentgen photographic measurements revealed that in the immediate vicinity of the electron gun and discharge tube the radiation was of the order of 1 r in three hours and, at the rectangular opening, 1.5 to 2 r in three hours. These amounts represent values which even at a distance of 3 feet from the instrument are considerably above the currently advocated tolerance dose of 6.25 mr per hour.

Measurements carried out around an electron microscope yielded similar results although here the figures were somewhat lower. A fifteen hour film exposure indicated 0.05 r at the final viewing chamber (without tilting of the screen); 0.13 r at the diffraction port and 0.175 r at the edge of the electron gun housing. When the screen of the final viewing chamber was tilted about 30 degrees, the emerging roentgen radiation amounted to 12 mr per hour which is considerably above tolerance.

The author discusses at length the implied effects which such radiation may have on the working personnel, especially as regards the problem of cumulation over a long period of time.

The following safety recommendations are proposed: (1) a survey similar to that made by the author should be carried out when installing any electron-beam instrument; (2) metallic (lead) shielding should be used around the electron area; (3) plate glass in the vicinity of the critical areas should be replaced by lead glass; and (4) a health physics program should be instituted for the operating personnel.—*T. Leucutia, M.D.*

HEUSTIS, ALBERT E., and VAN FAROWE, DONALD. The hazard of radiation. *Radiology*, Dec., 1951, *57*, 832–836.

The diagnostic equipment in eleven Michigan mental hospitals was checked with respect to radiation hazard. The type of installation varied widely with respect to layout and age of equipment. Because of the type of patient, an attendant was usually required to steady the patient during exposure. The radiation incident upon both the attendant and the technician was determined by a dosimeter for each technique employed. The number of times each technique was used for a month was recorded and the total exposure thus calculated. This total was correlated with a film badge worn during that period by the individuals in question. It was found that the attendant was exposed to more than 1.2 r per month at nearly all of the installations while the technician was exposed to less than the maximum accepted figure. Suggestions are made on how to minimize the radiation hazard of a diagnostic installation without major change with emphasis on rotation of attendants even though only a minimum amount of work is done.—*M. B. Goodwin, M.D.*